The Marsh Monitoring Program Annual Report, 1995-2003

Annual indices and trends in bird abundance and amphibian occurrence in the Great Lakes basin

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EXECUTIVE SUMMARY

Wetland loss in some areas of the Great Lakes basin has exceeded 80% since European settlement (Snell 1987, Dahl 1990). Marshes are the most ubiquitous wetland type (Weller 1981), and occur at both isolated inland and exposed lakeshore locations throughout much of the Great Lakes basin. Of all wetland types, marshes support the highest biomass and diversity of floral and faunal species (Weller 1978, Weller 1981), and are perhaps the most important natural mechanism for maintaining water quality to support life, including human life.

Many birds and amphibians frequent and rely heavily on marshes to support their annual life cycle (Weller 1999). With continual degradation and loss of marsh habitat, there has long been a recognized need to monitor populations of avian and amphibian species that rely on these sensitive wetland environments. In 1995, the Marsh Monitoring Program (MMP) was established as a bi-national Great Lakes basin-wide effort to monitor marsh bird and calling amphibian populations across this globally unique and water-rich region. This has been accomplished through a partnership between Bird Studies Canada, Environment Canada, the United States Environmental Protection Agency, Great Lakes United, and hundreds of citizen scientists. Through this multi-partner effort, the MMP has succeeded in capturing important and meaningful population and wetland habitat information from hundreds of wetlands throughout the Great Lakes basin.

To survey marsh habitats, MMP volunteers follow a standardized protocol and are guided by detailed written and aural training materials. Surveys are conducted at semi-circular monitoring stations positioned along routes. A nocturnal survey is conducted three times during spring and early summer for calling frogs and toads, and an evening survey is conducted twice during the height of breeding season for marsh birds. The marsh bird survey is augmented by the use of taped broadcasts to elicit response calls from several secretive species. MMP participants also provide assessments of wetland habitats at each survey station.

Data summaries in this report provide an overview of information contributed by MMP surveyors from 1995 through 2003. Most summaries focus on the Great Lakes basin, but data are also presented for individual lake basins. In total, 681 volunteers submitted data from 752 routes during the period 1995 through 2003. Most routes (652 routes, 86.7% of total) were within the Great Lakes basin but a small proportion (100, 13.3%) occurred outside the basin. Lake Erie, Ontario and Huron basins contained the most routes (219, 203 and 114, respectively) with fewer routes in the Lake Michigan and Superior basins (84 and 32, respectively).

Forty-nine species of birds that use marshes for feeding, nesting or both were commonly recorded by MMP observers at Great Lakes routes. Among birds that typically feed in the air above marshes, Tree and Barn Swallow were most common. Red-winged Blackbird was the most commonly recorded marsh nesting species, followed by Swamp Sparrow, Common Yellowthroat, Song Sparrow and Marsh Wren. Several obligate marsh nesting species were also observed at substantial numbers of stations. Many of these species (e.g., Virginia Rail, Black Tern, Common Moorhen, Pied-billed Grebe and Sora) are not well surveyed by other monitoring programs.

Individual bird species varied considerably in their distribution among lake basins. This could be attributed to differences in species' geographic range and variation in wetland habitat characteristics among basins. In general, station occupancy of most bird species tended to be highest in the Lake Erie, Michigan and Ontario basins, intermediate in the Lake Huron basin, and lowest in the Lake Superior basin. Although additional years of data are required to estimate population trends with strong precision, results of preliminary analyses are presented for species that were present on at least 10 routes. Statistically significant declining trends were detected for American Bittern, Black Tern, Blue-winged Teal, Common Moorhen, Least Bittern, Marsh Wren, Moorhen/Coot, Pied-billed Grebe, Red-winged Blackbird, Sedge Wren, Sora, Tree Swallow and Virginia Rail. Statistically significant increases were detected for American Black Duck, Cliff Swallow, Common Yellowthroat, Great Blue Heron, Green-winged Teal, Mallard, Northern Rough-Winged Swallow, Willow Flycatcher and Yellow Warbler. For many of these species, observed trends are attributable to significant declining/increasing trends within just one or a few basins, rather than to consistent declining/increasing trends throughout all lake basins. On average, about 240 routes were surveyed annually between 1995 and 2003. Based on a power analysis of MMP data completed by Timmermans and Craigie (2002), this level of route survey coverage suggests that the current level of effort is adequate for detecting statistically and biologically meaningful changes in annual indices for more than half of the 33 bird species recorded as commonly occurring at MMP routes.

MMP surveyors recorded 13 species of calling amphibians within the Great Lakes basin between 1995 and 2003. Eight species were detected at greater than 15% of station-years. Of these eight species, Spring Peeper was the most frequently detected species followed by Green Frog. Grey Treefrog, American Toad and Northern Leopard Frog were moderately common, while Bullfrog, Chorus Frog, and Wood Frog were the least common. The distribution of these eight species varied among lake basins. For example, Spring Peeper was encountered frequently in all Great Lake basins but least often in the Lake Ontario basin. Northern Leopard Frog, on the other hand, was detected most frequently in the Lake Ontario and Erie basins. Because the ranges of most species extend the breadth of the Great Lakes basin, patterns are likely due to differences in habitat preference, regional population densities, or to other factors such as timing of survey visits, as opposed to range limitations. Although the MMP has yet to gain long-term population-monitoring data, some apparent significant decreasing temporal trends were suggested for populations of Bullfrog, Chorus Frog, Green Frog and Northern Leopard Frog. Basin-wide increasing trends were observed for Cope's Grey Treefrog, Grey Treefrog and Spring Peeper.

This report summarizes the first nine years of MMP implementation across the Great Lakes basin and shows how MMP is playing a role in many of today's (and tomorrow's) conservation issues and actions at different scales. In addition, this report is a statement of appreciation to those agencies and foundations that have supported the MMP throughout the years. Finally yet importantly, this report is intended to convey to the hundreds of Great Lakes citizens who have volunteered with the program that their contributions remain both highly valued and extremely important.

INTRODUCTION

Numerous marsh bird and amphibian species are believed to be sensitive to habitat disturbances, and many scientists and conservationists consider their populations to be at risk due to continued habitat loss. For instance, marsh birds as a group are believed to have experienced population declines due to historical habitat loss and degradation (Gibbs et al. 1992, Conway 1995, Melvin and Gibbs 1996). Further, concern for declining amphibian populations is recognized internationally (Heyer et al. 1994, Stebbins and Cohen 1995). Efforts to monitor and evaluate relative status of marsh birds and amphibians across the Great Lakes basin are therefore essential to understanding how well marshes across the basin are functioning to maintain ecological integrity.

The Marsh Monitoring Program (MMP) has been monitoring trends in marsh bird and calling amphibian occurrence indices for ten years. This report summarizes results of bird and anuran (frogs and toads) annual abundance and occurrence surveys, respectively, that were performed throughout the Great Lakes basin from 1995 through 2003. The report also describes trends in relative abundance and occurrence of marsh birds and calling amphibians. These analyses, possible through the participation of hundreds of MMP volunteer participants, are being used to assist efforts to conserve and rehabilitate wetlands, to provide critical information for effective wetland management, and to propose conservation practices to benefit wetland-dependent wildlife and people. MMP data are also used by local groups to better understand and maintain wetlands in their locales, and contribute to management plans at the regional scale (e.g., Great Lakes Areas of Concern), individual lake basin scale (e.g., Lakewide Management Plans), and to wetland health assessment at the Great Lakes basin scale (e.g., State of the Lakes Ecosystem Conference). Moreover, MMP data serve to increase awareness of marsh bird, amphibian, and wetland habitat conservation issues through volunteer participation and communication to the public, scientists and regulators.

In this report, summaries of population trends are provided for marsh birds and amphibians for the first nine years of MMP implementation across the Great Lakes basin. General trends are provided for several marsh dependent bird and calling amphibian species that occur with some regularity throughout the Great Lakes basin. These data are assessed across the entire Great Lakes basin, and less extensively at the individual lake basin level.

METHODS

MMP volunteers in both Canada and the United States contribute their valuable time to monitor abundance and occurrence of marsh birds and calling amphibians throughout marshes in and around the Great Lakes basin. For the purposes of this report, analyses focused on results of MMP surveys conducted by volunteers within the Great Lakes basin (Figure 1) and concentrated on results for marsh birds and calling amphibian species believed to be most clearly associated with marshes and other wetland and aquatic habitats. Key elements of MMP sampling methodology are reported herein, and additional detailed information concerning MMP protocol and methodology can be found in Anonymous (2001).

Selection and Characteristics of Routes and Stations

Upon registering with the MMP, volunteers receive training kits that include detailed protocol instructions, field and summary data forms, instructional cassette tapes with examples of songs and calls of common marsh birds and amphibians, and a broadcast tape used to elicit calls from secretive wetland bird species. MMP volunteers establish survey routes in marshes at least 1-ha in size. Each route consists of one to eight monitoring stations depending on factors such as available time and marsh habitat size. Each marsh bird survey station must be separated by at least 250 m (275 yd) to minimize duplicate counts of individuals. For amphibians, this distance is extended to 500 m (550 yd) because observers record all anurans heard inside and beyond the 100 m station boundary (i.e., within hearing distance).

An MMP station is defined as a 100 m (110 yd) radius semicircle with marsh habitat covering greater than 50% of the semicircular area. Marsh habitat is defined as habitat regularly or periodically wet or flooded to a depth of up to two metres (six feet) where cattail, bulrush, burreed and other non-woody vegetation is predominant. Counts are conducted from a focal point at each station – the surveyor stands at the midpoint of the 200 m (220 yd) semi-circular base and faces the arc of the station perimeter. Each focal point is permanently marked with a stake and metal tag to facilitate relocation within and between years.

Bird Survey Protocol

Survey visits for birds are conducted twice each year between May 20 and July 5, with at least 10 days occurring between visits. Visits must begin after 18:00 h under appropriate survey conditions (i.e., warm, dry weather and little wind). A five-minute broadcast tape is played at each station during the first half of each 10-minute survey visit. The broadcast tape contains calls of the normally secretive Virginia Rail, Sora, Least Bittern, Common Moorhen, American Coot and Pied-billed Grebe and is used to elicit call responses from those species. During the count period, observers record onto a field map and data form, all birds heard and/or observed within the survey station. Aerial foragers are also counted and are defined as those species foraging within the station area to a height of 100 m (110 yd). Bird species flying through or detected outside the station are tallied separately.

Amphibian Survey Protocol

Amphibians surveyed by MMP volunteer participants are calling frogs and toads that typically depend on marsh habitat during spring and summer breeding periods. MMP routes are surveyed for calling amphibians on three nights each year, between the beginning of April and the end of July, with at least 15 days occurring between visits. Because peak amphibian calling periods are more strongly associated with temperature and precipitation than with date, visits are scheduled to occur on three separate evenings according to minimum night air temperatures of 5 °C (41 °F), 10 °C, (50 °F), and 17 °C (63 °F), respectively.

Amphibian surveys begin one-half hour after sunset and end before or at midnight. Visits are conducted during evenings with little wind, preferably in moist conditions with one of the above corresponding temperatures. During three-minute survey visits, observers assign a Call Level Code to each species detected; for two of these levels, estimated numbers of individuals are also recorded. Call Level Code 1 is assigned if calls do not overlap and calling individuals can be discretely counted. Call Level Code 2 is assigned if calls of individuals sometimes overlap, but numbers of individuals can still reasonably be estimated. Call Level Code 3 is assigned if so many individuals of a species are calling that overlap among calls seems continuous (i.e., full chorus); a count estimate is impossible for Call Level Code 3 and is not required by the protocol.

Beginning in 1999, MMP participants were asked to use their best judgment to distinguish whether each species detected was calling from inside the station boundary only, from outside the station boundary only, or from both inside and outside the station boundary. Combined with habitat information provided for each station by MMP surveyors, this modification will improve information concerning amphibian habitat associations.

Population Trend Analyses

Abundance and occurrence indices were derived for bird and amphibian species, respectively, in each survey year, both across the entire Great Lakes basin, and for each lake basin separately. We also combined data from the Lake Huron and Michigan basins to derive population indices for the combined Lake Huron-Michigan basin because, hydrologically these basins are essentially the same water body, separated only by a narrowing of the upper Lake Michigan basin.

For marsh birds, abundance indices were based on counts of individuals inside the MMP station boundary and were defined relative to 2003 values. General models (PROC GENMOD; SAS Institute Inc. 1999) were developed to generate annual indices for each marsh bird species. Indices were scaled to correct for over-dispersion before transformation for regression analyses. The overall effect of year as a class variable or as a continuous variable was tested using likelihood ratio tests (PROC GENMOD; SAS Institute Inc. 1999) to determine whether the addition of year to the model significantly increased the fit of the model. For each year, 95% confidence limits around each annual index were calculated. Presented in each figure and table herein are estimated annual percent changes (trends) in abundance of each marsh bird species and the associated upper and lower extremes of the 95% confidence limits for each species trend. Because actual counts of marsh birds provide a Poisson distribution of observations, Poisson regression was used to evaluate year-to-year variance of annual indices and overall direction of trends across years.

For calling amphibians, basin-wide trends in station occupancy were assessed for those species that were detected on greater than ten survey routes. For each species, a trend was assessed first on a route-by-route basis in terms of annual proportion of stations with each species present. These route level trends were then combined for an overall assessment of trend for each species, and were defined relative to 2003 values. As with birds, indices were scaled to correct for over dispersion before transformation for regression analyses. The overall effect of year as a class variable or as a continuous variable was tested using likelihood ratio tests (PROC GENMOD; SAS Institute Inc. 1999) to compare deviance of these models to models with no year variable. For each year, 95% confidence limits around each annual index were calculated. Annual percent change (trends) in occurrence of each amphibian species was also estimated, and the associated upper and lower extremes of the 95% confidence limits of each species trend are presented herein. Because amphibian indices were derived based on presence or absence of a species at a station, logistic (or binary) regression was used to evaluate year-to-year variance of annual indices and overall direction of trends in amphibian occurrence across years.

Statistically testing for year-to-year variance of abundance and occurrence indices provides knowledge about whether such indices for a given species were similar or different among years, whereas statistically testing for overall magnitude and direction of trends across years evaluates whether temporal trends differ from a slope of zero (i.e., no change). It is important to emphasize that the most meaningful interpretation of results is done by assessing both year-to-year variance in annual indices as well as overall magnitude and direction of trends. For example, a species may exhibit high year-to-year variance in its annual indices, yet the overall trend through time may not differ from a slope of zero. Similarly, a significant positive or negative trend over time for a given species may be driven by a single outlying year-specific index value that differs considerably from those of all other years combined. In the latter example, significant year-to-year variance in indices may not occur, and such a scenario is less meaningful than if both year-to-year variance and overall direction of a trend has occurred (i.e., each or most years having contributed to the overall increase or decline in trends).

RESULTS

In this report, bird and amphibian results are often summarized in terms of route-years, which considers every route surveyed in a given year as a single observation and does not differentiate between routes surveyed for a single or multiple years. Similarly, the term station-year refers to those analyses that considered stations without regard to the number of years that each station was surveyed. Unless otherwise mentioned, most analyses in this report were based on route-year and station-year approaches.

Routes

In total, 681 volunteers submitted data from 752 routes from 1995 through 2003. Most routes (652 routes, 86.7% of total) were within the Great Lakes basin. Of the individual lake basins, the Lake Erie basin contained the most routes (219, 29.1% of total), followed by the Lake Ontario (203, 27.0% of total) and Lake Huron (114, 15.2% of total) basins; fewer routes occurred in the Lake Michigan (84, 11.2% of total) and Lake Superior (32, 4.3% of total) basins (Table 1). Within the entire Great Lakes basin, survey data from 496 amphibian routes and 433 bird routes were submitted during the nine-year period. A greater number of routes were surveyed for amphibians only (219) than for birds only (156), and the number of routes surveyed for both birds and amphibians was even greater (277; Table 1). The mean number of routes surveyed per year was 240 and peaked in 1997 (Table 1). Overall, a large percentage of amphibian routes (40%) were surveyed for one year only, fewer for two, three, or four years (16.8%, 10.1% and 10.1%, respectively) and below 10% for additional years (Table 2). Similarly, a large percentage of bird routes (39.7%) were surveyed for only one year (Table 2). Seventeen percent of bird routes were monitored for two years, 9.8% for three years and between 4 and 6.5 percent for additional years. A higher proportion of bird routes were monitored for the full 9-year period (5.4%), than were amphibian routes (2.3%). Routes within the Great Lakes basin had an average of 3.8 stations. Mean number of stations per route was similar for bird and amphibian routes and varied little across years or among lake basins (Figure 2).

Birds

MMP observers recorded 225 bird species from 1995 through 2003, with 207 of these species counted inside MMP station boundaries. Of the 49 species commonly recorded (present in at least 0.3% station-years) by MMP observers on Great Lakes routes, 29 are classified as either obligate or general marsh nesters, 10 are classified as aerial foragers above marshes and 8 typically use marshes for foraging in water (water foragers). Included in the water forager classification are several species of waterfowl. Although data are presented for these species, population indices of waterfowl should be interpreted with caution because of the limitations of the current MMP protocol to adequately detect those species. Similarly, population indices for the American Coot and Common Moorhen may be inaccurate because their calls can often be difficult to distinguish. Thus, this species is also summarized as a combined "species"

(MOOT) to account for records where MMP volunteers were unable to differentiate between the two species.

Bird Detection Rates and Average Count

Of the aerial foraging species observed, Tree and Barn Swallows were the most common, and were recorded in 55.8% and 25.9% of station-years, respectively (Table 3). The other eight aerial foraging species occurred much less frequently (<10% of station years). Red-winged Blackbird was the most commonly recorded marsh nesting species, occurring in 90.1% of station-years. Swamp Sparrow was observed in 46.6% of station-years, and four other songbirds (Yellow Warbler, Common Yellowthroat, Song Sparrow and Marsh Wren) were almost as common. Several other marsh nesting species were observed in approximately 10 to 25% of station years. Of special note among these species are several water birds not well surveyed by other monitoring programs: Virginia Rail, Moorhen/Coot (undifferentiated), Black Tern, Common Moorhen and Pied-billed Grebe.

With respect to the average number of individuals recorded at a station among routes where they occurred, Tree Swallow and Red-winged Blackbird occurred in the highest numbers, with greater than five individuals per station, respectively. Common Grackle, Moorhen/Coot, Canada Goose, Black Tern, Yellow-headed Blackbird, Barn Swallow, Bank Swallow, Purple Martin, Chimney Swift, Mallard and Ruddy Duck each averaged greater than three individuals per station on routes where they occurred. In contrast, bitterns tended to be observed individually at a station on routes where they occurred (Table 3).

More marsh nesting and aerial foraging birds were detected at stations in the four lower Great Lakes than on routes in the Lake Superior basin (Table 3). In contrast, several bird species (Swamp Sparrow, Song Sparrow, Canada Goose and Alder Flycatcher) were detected on a relatively high proportion of Lake Superior stations as compared to other basins. Most species also differed in their frequency of occurrence among lake basins. For example, American Bittern was detected most frequently in the Lake Huron basin, while Least Bittern occurred in similar proportions of station-years across the Erie, Huron and Ontario basins, and less often in the Lake Michigan and Superior basins. Virginia Rail and Sora also differed among basins in their occurrence, with the former detected most often in Lake Huron and Ontario basins and the latter detected in similar proportions of stations across all basins, except the Lake Erie basin (Table 3). Almost all records of Alder Flycatcher occurred in the Lake Superior basin, while Willow Flycatcher was detected in similar proportions across the Lake Erie, Michigan and Ontario basins but less so in the Lake Huron and Superior basins. Pied-billed Grebe was also detected across all lake basins, but was detected more often in the Lake Huron basin, and least often in the Lake Superior basin. Black Tern was detected considerably more often in the Lake Huron basin compared to all other basins.

Bird Abundance Indices and Trends

Abundance indices and trends of marsh birds (i.e., average annual percentage change in abundance index) were analyzed for species that were observed on greater than 10 routes from 1995 through 2003 (Tables 5a-f). Species with a significant Great Lakes basin-wide declining trend were American Bittern, Black Tern, Blue-winged Teal, Common Moorhen, Least Bittern, Marsh Wren, Moorhen/Coot, Pied-billed Grebe, Red Winged Blackbird, Sedge Wren, Sora, Tree Swallow and Virginia Rail. In contrast, American Black Duck, Cliff Swallow, Common Yellowthroat, Great Blue Heron, Green-winged Teal, Mallard, Northern Rough-winged Swallow, Willow Flycatcher and Yellow Warbler all showed a significant increasing trend between 1995-2003. ($P < 0.05$) (Table 5a).

For many species, changes in abundance indices occurred in only some lake basins. For instance, Black Tern abundance decreased significantly in Lake Huron, Huron-Michigan and Ontario basin MMP routes ($P < 0.05$)(Tables 5c,d,f), but was relatively stable in routes of the Lake Erie basin (Tables 5e). Common Yellowthroat abundance increased significantly in the Lake Michigan and the Lake Huron-Michigan basin ($P < 0.05$)(Tables 5b,d) but did not show a significant trend in the other basins. Moorhen/Coot and Pied-billed Grebe abundance decreased significantly in all but the Lake Ontario and Lake Erie basin, respectively ($P < 0.05$)(Tables 5b-f). Great Blue Heron populations increased significantly in the Lake Erie basin, but did not show a significant trend in the other lake basins. Red-winged Blackbird abundance decreased significantly in Lake Huron, Huron-Michigan and Erie basins, ($P < 0.05$)(Tables 5c-e).

Amphibians

Amphibian Detection Rates and Average Calling Code

MMP surveyors recorded 13 species of calling amphibians from 1995 through 2003. Spring Peeper was the most frequently detected species (69.9% station-years) and was recorded with the highest average calling code (2.5; Table 4). Green Frog was the next most frequently detected species (54.7% station-years), but its average calling code, along with the calling code of all other detected species, was below 2. This suggests that although the Green Frog was detected frequently, on average only a small number of individuals were detected at a given station. Grey Treefrog, American Toad and Northern Leopard Frog were also common and were recorded in greater than 30% of station-years. Bullfrog, Chorus Frog and Wood Frog were detected in 18-30% of station-years, while the remaining five species were detected infrequently by MMP surveyors and were recorded in less than 3% of station-years (Table 4).

The eight amphibian species commonly detected (present in at least 3% of station-years) by MMP surveyors varied to some extent in their frequency of occurrence among lake basins (Table 4). American Toad was detected with similar frequencies among all lake basins. Green Frog occurred in greater frequencies in the Lake Erie, Huron, and Ontario basins, as opposed to the

Northern Leopard Frog, which was detected most often in the Lake Erie and Ontario basins. Bullfrog was recorded most frequently in the Lake Erie basin, and Spring Peeper was recorded most frequently in the Lake Erie, Huron, Michigan, and Superior basins.

Amphibian Occurrence Indices and Trends

Great Lakes basin-wide declining trends for Bullfrog, Chorus Frog, Green Frog and Northern Leopard Frog, and basin-wide increasing trends for Cope's Grey Treefrog, Grey Treefrog and Spring Peeper could be resolved with sufficient statistical confidence (i.e., confidence limits do not encompass zero; Table 6a). However, for some species, changes in trends were strongest only in specific lake basins. For instance, a significant basin-wide decline in occurrence of Green Frog appeared to be largely due to declines in the Lake Michigan and Huron basins ($P < 0.05$)(Tables 6b,c,d) because occurrence in the Lake Erie and Ontario basins did not show a significant trend. Also, although a basin-wide decline is not observed for American Toads, this species has experienced a significant decline in the Lake Michigan and Huron basins, and a marginally significant decline in the Lake Erie basin (Tables 6a-e). Although Bullfrog occurrence increased significantly in the Lake Huron basin (Tables 6c), significant declines in occurrence for this species occurred in the Lake Erie and Lake Ontario basin MMP routes ($P < 0.05$) (Tables 6e,f). Chorus Frog station occurrence declined significantly in the Lake Huron basin and the Huron-Michigan complex, and also in the Lake Ontario basin ($P < 0.05$)(Tables 6c,d,f). Spring Peeper occurrence also declined significantly in the Lake Huron basin and Lake Huron-Michigan complex ($P < 0.05$)(Table 6c,d), but showed a significant increase in the Lake Erie and Ontario basins ($P < 0.05$)(Table 6 e,f). Northern Leopard Frog occurrence declined significantly in the Lake Erie basin, showed marginally significant declines ($P < 0.1$) in the Lake Huron basin (Tables 6c,d,e), but increased significantly in the Lake Ontario basin ($P < 0.05$)(Table 6f).

DISCUSSION AND CONCLUSIONS

Summaries of data presented in this report are intended as an overview of the types of information contributed by MMP volunteers and to demonstrate the breadth of ongoing analyses. Additional years of data will lead to improved resolution of trends for amphibians and birds. Since the inaugural five-year assessment was undertaken (Weeber and Vallianatos 2000), four additional years of MMP volunteer data have been examined. We discuss below species-specific, basin-specific and basin-wide trends and changes that have occurred from 1995 through 2003.

Routes

Route turnover by MMP volunteer surveyors, a problem experienced during earlier years of the MMP, has been similar during the last four years of surveying. However, a lower proportion of total MMP routes have been surveyed for marsh birds and amphibians for three or fewer years (66.9% and 66.6%, respectively) than when first examined in 1999. Increased MMP route retention (i.e., monitoring through time) by the same volunteers will allow for more accurate assessments of population indices and habitat associations of marsh birds and amphibians throughout the Great Lakes basin.

Fewer MMP routes have been established in the Lake Superior basin than in other basins, and this is due to the relative scarcity of available surveyors in this region, not to the lack of available wetland habitat. Recent collaboration with the Lake Superior Binational Forum is working to address this deficiency and to increase MMP monitoring coverage and volunteer participation in the Lake Superior basin. Initial effort by MMP volunteers to survey wetlands in Areas of Concern throughout the Great Lakes basin when the program was initiated in 1995 has also driven the spatial pattern of MMP route distribution to some degree.

Birds

The number of years of monitoring required to provide adequate resolution on bird relative abundance trends was assessed by Timmermans and Craigie (2002) based on seven years of MMP data collected from 1995 through 2001. The annual trend (i.e., percent change in population index based on counts) that could be detected was calculated assuming that either 100, 200 or 300 routes were monitored over three, five, or ten years (Timmermans and Craigie 2002). Although a standard has not yet been determined, many bird-monitoring specialists consider a 3% annual trend as a reasonable criterion for adequate resolution of bird trends. Assuming at least 100 routes are surveyed for 10 years, good trend resolution is expected for 15 of 33 species commonly recorded on MMP routes (see Timmermans and Craigie 2002; Table 5). Twenty-three MMP routes were surveyed annually for marsh birds between 1995 and 2003; meaning relatively few routes were surveyed consecutively for the nine-year duration. Although the net number of routes surveyed each year may appear adequate, the current rate of route turnover may be problematic. Regardless, monitoring data to estimate annual indices of species abundance need not be derived from the same routes if one assumes that the composition of marshes being surveyed each year does not change drastically among years. In fact, results from the previously described power analyses were derived from the MMP dataset, which inherently includes a certain level of route turnover among year-pairs. Thus, although more years of data collection are required to reliably estimate abundance trends of marsh birds with desired precision, there is merit in discussing results from analyses for those species for which sufficient data were available.

With the current nine years of MMP data, Black Tern, Blue-winged Teal, Common Moorhen, Least Bittern, Marsh Wren, Moorhen/Coot, Pied-billed Grebe, Red-winged Blackbird, Sedge Wren, Sora, Tree Swallow and Virginia Rail continue to show basin-wide significant declines in abundance indices. Further, since we last reported in 2003, American Bittern has been added to the list of species showing significant negative population trends in the Great Lakes basin, and the previously significant negative trend observed for American Coot was only marginally significant with the addition of another year of data ($p<0.1$; Table 5a).

Most of the species experiencing significant declining trends depend upon wetlands for breeding, but because of their virtually exclusive use of marsh habitat, Black Tern, Common Moorhen, Least Bittern, Pied-billed Grebe, Sora, and Virginia Rail, are particularly dependent on availability of healthy marshes. Although declines in certain wetland dependant species and increases in some wetland edge species (e.g., Common Yellowthroat) and generalist species (e.g., Mallard, American Black Duck) suggest a deterioration of wetland habitat conditions, additional years of data and better understanding of species habitat preferences are required to better explain such patterns.

Due to the breadth of data across the Great Lakes basin, fluctuations in marsh bird indices can be narrowed down to trends occurring in specific lake basins. For instance, basin-wide increases in Common Yellowthroat abundance indices appear to be attributed primarily to increases in the Lake Michigan portion of the Lake Huron-Michigan basin. Basin-wide declines in Black Tern abundance indices appear to be driven by significant declines in the Lake Huron portion of the Lake Huron-Michigan basin and in the Lake Ontario basin. A decline in Pied-billed Grebe abundance indices appears to have occurred in all basins except Lake Erie. Similarly, basin-wide declines in Red-winged Blackbird abundance indices appear to be driven by all surveyed Great Lake basins with the exception of the Lake Ontario basin, where it is not experiencing a significant change in population size. Although additional years of data are necessary to assess abundance trends at the level of individual lake basins, the current assessments are strongest for those lake basins in which species occur most frequently and where survey coverage is greatest. Thus, bird species data gathered in the Lake Ontario, Erie and Huron basins provide a greater resolution for determining species population trends than does bird species data gathered in the Michigan and Superior basins.

Considerable differences are seen in marsh bird abundance indices in the Lake Superior basin MMP routes as compared to the rest of the basin. For instance, Red-winged Blackbird, the most frequently detected marsh bird species in the Great Lakes basin, was detected only about half as often in Lake Superior basin MMP routes. Similarly, Black Terns were detected less frequently on Lake Superior basin MMP routes than in the other basins. Alternatively, Alder Flycatcher and Sedge Wren were detected most commonly on MMP survey routes located in the Lake Superior basin. This may be attributed to alternate physiographic and geologic preferences of these species (Chapman and Putnam

1984), and hence to the preference of alternate wetland types. For example, the Sedge Wren prefers marshes that offer adequate coverage of sedge meadow habitat. Sedge meadow habitats are dominant in Lake Superior marshes monitored by MMP volunteers (Timmermans and Craigie 2002), and likely attributes to the greater abundance of this species in that area. On the other hand, for some species, behavioural differences are the more likely explanation for the observed differences in the average number of individuals at a station. Species such as Canada Goose, Mallard and Ruddy Duck, which averaged greater than three individuals per station, are colonial and tend to travel in flocks. However, bitterns, which are more secretive in nature, were observed individually at a station.

The ecology of most marsh-dependent species has received relatively little attention and as a result, little is known about rails and other secretive species (Gibbs et al. 1992, Conway 1995, Melvin and Gibbs 1996, Conway and Timmermans 2005). Marsh birds are believed to be sensitive to habitat disturbances, and many scientists and conservationists consider their populations to be at risk due to continued loss and degradation of their habitats. For instance, a substantial proportion of coastal marshes along Lake Ontario's shoreline have become choked with dense monotypic stands of cattail, likely because of reduced amplitude in water level changes (Timmermans 2002). Further, mean annual water levels of the Great Lakes has proven to be an important correlate and may explain much of the variation in many species trends (Timmermans 2002, Craigie *et al.* 2003, Timmermans *et al.* unpublished data). However, marsh bird species occurrence and abundance, and their activity and likelihood of being observed, vary naturally among years and within seasons, much of the latter of which is attributable to latitudinal differences in breeding phenology due to differences in the onset of favorable weather conditions. For these and other reasons, large numbers of observations, collected over many years, and timed to survey during equivalent weather conditions (i.e., peak breeding period), are required to reliably estimate population trends. Additional years of MMP monitoring data, particularly if augmented with intensive studies of individual species, will determine if patterns observed from current MMP data are representative of long term, persistent population trends.

Amphibians

This report focused on the more common amphibian species of the Great Lakes basin, but certain other species (ex. Fowler's Toad) are quite rare in parts of the Great Lakes and subsequently may require monitoring efforts more intensive than offered by the MMP. Because the relationship between calling codes and numbers of individuals is uncertain, the focus of this report is on amphibian species presence (or occurrence) at monitoring locations through time. Due to seasonal and annual variability in populations and other related factors, trend estimates for amphibians should be utilized and compared with other complimentary data for verification.

The eight amphibian species commonly detected by MMP surveyors (i.e., American Toad, Bullfrog, Chorus Frog, Green Frog, Grey Treefrog, Leopard Frog, Spring Peeper, and Wood Frog) varied in their relative occurrence among lake basins. Because the range of each species extends the breadth of the Great Lakes basin, these patterns are not likely due entirely to range limitations. Differences in habitats, regional population densities, timing of survey visits, breeding phenology or other factors are possible explanations. Basin-wide declining trends in occurrence were also detected for Bullfrog, Chorus Frog, Green Frog, and Northern Leopard Frog. Although Weeber and Vallianatos (2000) reported declining trends for American Toad and Bullfrog, only the Chorus Frog showed significant declines in the Great Lakes basin at that time. Results with four additional years of data show general steady declines in both Chorus Frog and Bullfrog station occurrences, but the American Toad showed only basin-specific declining trends. Patterns of annual change and a general decline recorded for Green Frog, Northern Leopard Frog, Bullfrog and Spring Peeper are similar to the fluctuations in water level throughout most of the Great lakes during this period (see Timmermans 2002, Timmermans *et al.* unpublished data), and this correlation should be investigated further.

The extent to which additional years of data may be expected to provide adequate resolution on amphibian occupancy trends was assessed by Timmermans and Craigie (2002) based on seven years of MMP data collected from 1995 through 2001. The annual trend (i.e., percent change in relative occurrence index based on station occupancy) from 50% occupancy that could be detected was estimated assuming that either 100, 200 or 300 routes were monitored over three, five or ten years (see Timmermans and Craigie 2002; Table 4). They showed that for 100 routes measured for 10 years, the estimated annual change from 50% occupancy that could be detected was about 1% per year or less for all of the eight amphibians commonly recorded on MMP routes. Resolution improved with 200 and 300 routes, respectively. Expected resolution on trends was best for American Toad and Green Frog, followed by Bullfrog, Chorus Frog, Grey Treefrog and Northern Leopard Frog. Resolution was lower for species that were less common (i.e., Wood Frog) or that exhibited large fluctuations in station occupancy (i.e., Spring Peeper).

Most hypotheses concerning global declines in amphibian populations relate to anthropogenic disturbances such as pollution (e.g., acid rain, pesticides), habitat destruction (e.g., urbanization, agriculture), global climate change, and predation from introduced species (Hecnar 1997). Concerns about those population declines are heightened by our relatively poor understanding of amphibian biology, particularly population and community ecology (Hecnar 1997). Long-term population losses (1950s to 1990s) of such species as the Chorus Frog have been recorded in the St. Lawrence River valley just outside the Great Lakes basin and, even though population fluctuations and regional extinctions often occur (Daigle 1997), such trends are cause for concern.

Within the Great Lakes basin, MMP volunteer data have showed that declines in amphibian occurrence indices can vary among lake basins. For instance, basin-wide declines in the Green Frog are driven by significant declines in the Michigan and Huron basins, while the basin-wide decline in Bullfrog populations is driven by significant declines in the Erie and Ontario basins, despite a significant increase in the Lake Huron basin. Similarly, although the Spring Peeper shows a basin-wide increase in occurrence trend, this is driven primarily by significant increasing trends in the Lake Erie and Ontario basins despite a significant decline in occurrence in the Lake Huron part of the Huron-Michigan basin. Nine years of MMP survey data is a relatively short timeframe to reliably determine population trends, however, resolution of trend detection was high for most species (i.e., detect annual change of 1% or less). However, annual fluctuations of amphibian occurrence indices are apparent and many extrinsic factors may be attributed to those fluctuations. Further work is therefore required to test whether the observed population trends are correlated with anthropogenic factors such as urban development and water level stabilization.

RESEARCH NEEDS

Extensive monitoring and broad comparisons of species trends with components of their changing environment are important to maintain conservation efforts and to address questions about how to better direct conservation efforts of wetland ecosystems. Such approaches often benefit from intensive experimentation to determine if observed correlations are due to causal mechanisms. However, even improvement in extensive monitoring efforts and rigorous attempts to improve robustness of sampling design and comparative approaches can greatly improve confidence in correlative approaches. For example, obtaining geo-referenced locations of Marsh Monitoring Program route stations is greatly aiding our ability to assess habitat and landscape level regimes (including water levels) through the use of Geographic Information System modeling and analyses. Such approaches will allow rigorous assessment of temporal and spatial patterns both within MMP surveyed marshes, and throughout adjacent landscapes, which can have marked effects on marsh community dynamics (Riffel et al. 2001). Although many of our routes are now geo-referenced to the location of each route, coordinates for most stations are lacking.

The best way to ensure that MMP results are representative of the Great Lakes basin is to randomly sample among an inventory of available wetlands across geomorphologic and habitat-based strata. The degree to which the MMP's volunteer-selected marshes are representative of the Great Lakes basin is currently unknown and depends on criteria of interest. For example, the observed species population densities may not be representative of the entire basin if there is geographic variation in marsh density across the basin and the full variation in population density is not sampled, or if sampled marshes are concentrated primarily in certain regions of the basin. Regardless, if selected marshes do adequately convey the full range of variation in population trends, the population trends reported here may be representative of population trends across the entire basin. Due to the volunteer nature of the MMP surveyor-base, complete randomization of the survey is not practically feasible and may not be desirable. However, a gap analysis should be performed to determine whether the current MMP route coverage adequately samples the available geomorphic and habitat-based strata. Alternatively, a random sampling procedure could be developed to test whether the current non-random sampling approach adequately covers all marsh habitat types and basins. Such a design, if implemented, should also attempt to sample marsh habitats across the available hydrologic spectrum (i.e., whether they have water or are dry in a given year). This will enable us to test hypotheses about the possible causes of observed population changes. This type of research will depend on our ability to access a useable inventory of all marshes in the Great Lakes basin. An inventory of coastal marshes across the Great Lakes basin is currently available (Environment Canada et al. 2004), but is still lacking for many inland marshes in certain areas of the basin.

Trend results for marsh birds and amphibians would benefit from a comparison with results derived from intensive species- and site-specific sampling. Such sampling could experimentally test how year-to-year changes in water level regimes of marshes affect populations by sampling at non-manipulated control sites and comparing results with those from experimental treatments under different degrees of water level control. Work is currently underway by Environment Canada in Ontario to begin comparisons among bird and vegetation communities of diked and un-diked wetlands. Combining knowledge gained from such results with species specific habitat associations of marsh dependent birds and amphibians would greatly compliment our efforts to conserve and restore damaged and degraded wetland ecosystems for the benefit of entire marsh ecosystems throughout the Great Lakes region.

Finally, trend results from the MMP should be compared against results from other monitoring programs in place in the Great Lakes basin and elsewhere. Cross-correlation of results across programs provides correlative evidence and support for validity of the results. There are several other regional programs in place that are collecting data on amphibian populations. It is important that these data sets are analyzed and that information is shared, to enable validation of the merit of the different programs and collectively provide more compelling results. Likewise, MMP results for marsh birds can, and should, be compared with Breeding Bird Survey results from the Great Lakes basin, at least for the most common species detected in both programs.

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TABLES

Table 1. Number of routes surveyed in each lake basin and over entire Great Lakes (GL) basin, summarized by routes surveyed for amphibians (a), birds (b) and both amphibians and birds (ab), 1995 through 2003.

	1995			1996			1997			1998			1999			2000			2001			2002			2003			Overall			Total
	a	b	ab	a	b	ab	a	b	ab	a	b	ab	a	b	ab	a	b	ab	a	b	ab	a	b	ab	a	b	ab	a	b	ab	
Erie	6	25	26	14	28	35	27	33	44	29	22	32	24	24	38	31	34	28	30	30	33	27	16	58	25	19	18	57	48	114	**219**
Huron	11	21	12	21	12	16	35	11	13	21	13	10	21	14	12	16	12	7	26	11	11	20	10	10	15	9	11	53	29	32	**114**
Michigan	6	8	6	18	10	7	23	13	13	16	12	11	14	10	10	11	9	13	18	10	8	10	7	5	15	9	6	33	22	29	**84**
Ontario	22	19	23	23	24	30	24	20	27	24	18	23	22	20	21	22	18	26	19	19	18	30	26	31	32	23	29	68	46	89	**203**
Superior	2	4	1	4	6	9	1	3	1	0	5	2	0	4	1	1	3	3	0	3	3	0	4	3	2	5	2	8	11	13	**32**
GL Basin	47	77	68	80	80	97	110	80	98	90	70	78	81	72	82	81	76	77	93	73	73	87	63	107	89	65	66	219	156	277	**652**
Total # Routes	192			257			288			238			235			234			239			257			220			**652**			

Table 2. Number and percentage of MMP amphibian and bird routes surveyed for 1 to 9 years, 1995 through 2003.

# Years Surveyed	# Amphibian Routes	% of Total	# Bird Routes	% of Total
1	190	40.0	170	39.7
2	80	16.8	73	17.1
3	48	10.1	42	9.8
4	48	10.1	22	5.1
5	39	8.2	25	5.8
6	10	2.1	18	4.2
7	27	5.7	27	6.3
8	22	4.6	28	6.5
9	11	2.3	23	5.4
Total	475	100	428	100

Table 3. Frequency of occurrence and average number of individuals (at routes where they occurred) of marsh nester, aerial forager and water forager bird species detected inside Great Lakes basin MMP stations, 1995 through 2002. Data are presented by group for each lake basin for those species detected on greater than 0.3 % station-years as averaged across the basin.

		Percent Station-Years Present [1]					
Group	Species	Lake Erie	Lake Huron	Lake Michigan	Lake Ontario	Lake Superior	Basin Average
Marsh Nesters	Red-winged Blackbird	94.2 (4.9)	86.1 (4.2)	90.9 (4.7)	92.5 (5.7)	46.6 (5.1)	90.1 (5.0)
	Swamp Sparrow	46.8 (2.2)	49.4 (2.1)	40.3 (2.1)	45.9 (2.5)	56.3 (1.7)	46.6 (2.2)
	Yellow Warbler	45.3 (1.7)	27.2 (1.6)	44.7 (1.6)	42.7 (1.9)	48.1 (1.8)	41.6 (1.7)
	Common Yellowthroat	48.5 (1.6)	34.6 (1.4)	50.7 (1.7)	31.7 (1.6)	49.0 (1.6)	41.6 (1.6)
	Song Sparrow	44.3 (1.5)	24.9 (1.4)	36.3 (1.6)	36.1 (1.5)	54.8 (2.3)	38.2 (1.6)
	Marsh Wren	36.3 (2.7)	31.3 (2.7)	30.6 (1.9)	39.6 (2.3)	8.7 (3.1)	34.7 (2.5)
	Virginia Rail	14.2 (1.4)	33.9 (1.7)	19.8 (1.8)	30.6 (1.5)	10.1 (1.3)	22.7 (1.6)
	Common Grackle	22.6 (3.3)	12.6 (5.5)	20.5 (2.9)	24.7 (4.0)	6.7 (3.4)	20.7 (3.7)
	Common Moorhen/American Coot	12.8 (3.6)	21.8 (4.3)	8.8 (3.9)	22.7 (4.1)	1.9 (2.5)	16.3 (4.0)
	Eastern Kingbird	13.6 (1.3)	14.8 (1.3)	11.4 (1.4)	10.8 (1.3)	3.4 (1.1)	12.3 (1.3)
	Great Blue Heron	12.0 (1.7)	7.1 (1.2)	10.9 (1.3)	12.6 (1.2)	13.9 (1.8)	11.3 (1.4)
	Canada Goose	11.5 (4.9)	8.6 (4.2)	10.6 (5.4)	11.0 (3.7)	22.1 (9.5)	11.2 (4.9)
	Black Tern	9.1 (2.3)	23.9 (5.6)	8.5 (3.0)	8.4 (2.7)	1.9 (1.8)	11.0 (3.7)
	Common Moorhen	7.0 (1.7)	11.3 (2.2)	2.8 (1.6)	18.5 (1.9)	0 (0)	10.3 (1.9)
	Pied-billed Grebe	8.4 (1.5)	18.2 (1.6)	10.4 (1.6)	8.2 (1.6)	3.8 (2.8)	10.0 (1.6)
	Sora	5.2 (1.2)	12.2 (1.3)	13.5 (1.3)	9.4 (1.2)	10.6 (1.4)	8.7 (1.3)
	Willow Flycatcher	7.3 (1.3)	2.1 (1.1)	7.6 (1.1)	7.6 (1.2)	0.5 (1.0)	6.3 (1.2)
	American Coot	3.8 (2.2)	7.9 (2.1)	5.5 (2.1)	4.9 (1.9)	1.9 (1.3)	4.9 (2.1)
	American Bittern	2.6 (1.1)	11.7 (1.2)	2.0 (1.2)	5.1 (1.1)	3.8 (1.0)	4.8 (1.1)
	Least Bittern	5.3 (1.1)	5.6 (1.2)	2.6 (1.2)	4.6 (1.1)	1.9 (1.0)	4.7 (1.1)
	Green Heron	5.5 (1.2)	1.1 (1.1)	6.0 (1.3)	4.9 (1.2)	0.5 (2.0)	4.4 (1.2)
	Alder Flycatcher	2.4 (1.1)	1.8 (1.1)	1.0 (1.0)	3.8 (1.3)	30.3 (2.3)	3.6 (1.6)
	Mute Swan	1.2 (1.9)	0.3 (2.7)	5.0 (4.2)	4.7 (1.5)	0 (0)	2.5 (2.3)
	Sedge Wren	0.7 (1.1)	2.0 (1.2)	3.3 (1.7)	1.2 (1.7)	11.1 (2.7)	1.8 (1.8)
	Common Snipe	0.4 (1.1)	4.7 (1.2)	2.4 (1.2)	1.0 (1.0)	5.3 (1.3)	1.7 (1.2)
	Forster's Tern	3.4 (1.5)	0 (0)	0.5 (1.3)	0.1 (2.0)	0.5 (1.0)	1.4 (1.5)
	Sandhill Crane	0.7 (2.1)	1.4 (2.3)	3.6 (2.0)	0 (0)	1.0 (2.0)	1.0 (2.1)
	Yellow-headed Blackbird	0.1 (2.5)	0 (0)	6.5 (3.2)	0.1 (2.0)	1.9 (4.0)	0.9 (3.2)
	Northern Harrier	0.5 (1.4)	0.2 (1.0)	0.2 (1.0)	1.4 (1.1)	1.0 (1.5)	0.7 (1.2)
	Ring-necked Duck	0.1 (3.0)	0.6 (1.6)	0.5 (2.0)	0.3 (2.4)	4.3 (3.7)	0.5 (2.7)
Aerial Foragers	Tree Swallow	60.6 (5.6)	46.1 (5.5)	61.5 (6.1)	55.4 (5.2)	35.1 (4.8)	55.8 (5.5)
	Barn Swallow	29.1 (3.2)	10.9 (3.3)	33.8 (3.6)	29.4 (4.2)	7.2 (2.1)	25.9 (3.6)
	Bank Swallow	8.7 (4.0)	2.9 (3.1)	2.1 (3.9)	13.1 (5.1)	2.9 (2.8)	8.0 (4.4)
	Purple Martin	12.2 (3.2)	1.5 (2.1)	3.7 (3.3)	4.2 (4.8)	0 (0)	6.6 (3.5)
	Belted Kingfisher	4.3 (1.1)	3.8 (1.1)	5.5 (1.0)	7.5 (1.2)	3.8 (1.0)	5.3 (1.1)
	Northern Rough-winged Swallow	6.2 (3.3)	1.7 (3.1)	4.6 (2.8)	5.5 (2.3)	1.4 (2.0)	4.8 (2.9)
	Chimney Swift	5.3 (3.1)	0.1 (1.0)	3.3 (2.2)	4.9 (3.8)	0.5 (1.0)	3.9 (3.3)
	Caspian Tern	0.7 (1.6)	6.3 (1.3)	0.7 (1.3)	2.7 (1.5)	0.5 (1.0)	2.2 (1.4)
	Cliff Swallow	0.6 (1.4)	0.9 (1.6)	1.1 (2.7)	2.0 (3.0)	2.4 (3.0)	1.2 (2.5)
	Common Nighthawk	0.6 (1.8)	0.8 (1.3)	2.1 (4.0)	1.6 (2.2)	1.4 (1.3)	1.1 (2.4)
Water Foragers	Mallard	17.7 (3.8)	13.1 (1.9)	13.3 (3.9)	19.7 (2.3)	35.1 (7.0)	17.7 (3.4)
	Blue-winged Teal	1.6 (1.6)	6.9 (2.1)	3.9 (1.8)	4.8 (1.8)	9.6 (1.8)	4.0 (1.8)
	Black-crowned Night-heron	1.5 (1.7)	0.9 (3.4)	2.6 (1.1)	3.1 (1.7)	0 (0)	1.9 (1.8)
	Green-winged Teal	0.3 (1.7)	0 (0)	2.0 (1.3)	1.0 (1.7)	3.8 (4.6)	0.8 (2.1)
	American Black Duck	0.3 (1.5)	0.9 (1.9)	0 (0)	0.7 (3.0)	4.8 (4.2)	0.6 (2.8)
	Gadwall	0.1 (2.5)	0.1 (1.0)	0 (0)	1.4 (1.6)	0.5 (2.0)	0.5 (1.7)
	Ruddy Duck	0.6 (4.2)	0.2 (2.0)	0 (0)	0.1 (1.5)	0 (0)	0.3 (3.6)
	Northern Shoveler	0 (0)	0.1 (2.0)	0 (0)	0.3 (1.2)	3.8 (2.3)	0.3 (1.9)

[1] Value in parentheses represents average count

Table 4. Frequency of occurrence and average calling code for amphibian species detected inside Great Lakes basin MMP stations, 1995 through 2003. Species are ordered by decreasing frequency of occurrence.

	Percent Station-Years Present[1]					
Species	Lake Erie	Lake Huron	Lake Michigan	Lake Ontario	Lake Superior	Basin Average
Spring Peeper	65 (2.4)	85.3 (2.7)	75.6 (2.5)	57.2 (2.5)	92.2 (2.5)	69.9 (2.5)
Green Frog	60.3 (1.3)	57.4 (1.4)	44.9 (1.2)	54.5 (1.3)	27.5 (1.1)	54.7 (1.3)
Grey Treefrog	31.4 (1.8)	46.7 (1.8)	54.3 (1.8)	38.4 (2.0)	30.4 (1.7)	40.6 (1.9)
American Toad	39.6 (1.5)	36.4 (1.5)	34.7 (1.5)	38.5 (1.5)	41.2 (1.7)	37.8 (1.5)
Northern Leopard Frog	39.4 (1.3)	24.6 (1.3)	16.8 (1.2)	41.7 (1.3)	16.7 (1.2)	32.1 (1.3)
Bullfrog	42.8 (1.3)	12.8 (1.4)	11.6 (1.1)	29.7 (1.3)	6.9 (1.0)	26.8 (1.3)
Chorus Frog	22.3 (1.7)	19.8 (1.5)	50.4 (1.7)	18.4 (1.8)	14.7 (1.7)	26.2 (1.7)
Wood Frog	12.5 (1.5)	27.7 (1.6)	22.3 (1.6)	15.8 (1.6)	27.5 (1.3)	18.6 (1.6)
Fowler's Toad	4.2 (1.4)	0.5 (1.2)	6.3 (1.5)	0.1 (2.0)	1 (1.0)	2.8 (1.4)
Pickerel Frog	2.8 (1.0)	1.1 (1.0)	3.1 (1.2)	2.8 (1.1)	8.8 (2.1)	2.6 (1.1)
Cope's Grey Treefrog	0.7 (1.3)	2.1 (1.5)	3.8 (1.2)	1.6 (1.6)	1 (1.0)	1.8 (1.4)
Mink Frog	0.2 (1.0)	2.7 (1.2)	1.1 (1.0)	1.3 (1.2)	10.8 (1.4)	1.3 (1.2)
Blanchard's Cricket Frog	0.1 (1.0)	0	2.5 (1.5)	0	6.9 (1.0)	0.7 (1.3)

[1] Value in parentheses represents average calling code

Table 5a. Annual abundance indices and trends in marsh bird populations throughout the Great Lakes basin, 1995-2003 *.

Species	Annual Abundance Indices 1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
ABDU	0.00	0.00	1.65	0.53	5.09	0.29	0.77	0.50	0.60	**<0.0001**	**18.8**	-5.8	49.8	**0.0336**
ALFL	0.60	0.74	0.75	1.00	0.99	1.28	0.84	0.98	0.71	0.7087	4.1	-3.7	12.5	0.3274
AMBI	0.45	0.71	0.80	0.83	0.32	0.45	0.39	0.47	0.30	**0.0167**	**-8.8**	-16.1	-1.0	**0.0246**
AMCO	2.33	4.97	2.02	3.72	1.06	2.43	1.20	3.25	2.04	**<0.0001**	-5.2	-11.1	1.1	0.0810
BANS	6.26	3.33	4.43	3.19	5.38	1.45	4.38	5.56	2.74	**0.0035**	-3.0	-9.8	4.2	0.3675
BARS	4.74	4.90	4.34	4.88	5.02	4.83	5.54	4.53	5.19	0.8454	1.2	-1.9	4.3	0.4586
BCNH	0.62	1.06	1.19	1.13	0.48	0.97	0.31	0.83	0.81	0.3491	-2.7	-11.9	7.5	0.5951
BEKI	0.42	0.51	0.45	0.42	0.36	0.46	0.44	0.30	0.72	0.2664	1.8	-4.2	8.2	0.5642
BLTE	11.60	8.72	6.40	8.13	3.76	3.26	3.95	3.64	2.45	**<0.0001**	**-17.1**	-21.4	-12.6	**<0.0001**
BWTE	1.77	1.51	1.23	1.60	0.84	0.98	0.90	0.53	0.77	**0.0353**	**-12.0**	-18.2	-5.3	**0.0005**
CAGO	4.19	4.33	3.99	6.72	5.57	4.69	4.46	4.81	2.56	**0.0179**	-3.0	-7.9	2.1	0.2404
CATE	0.20	0.41	0.58	0.60	0.24	0.35	0.46	0.41	0.67	0.3057	3.0	-6.7	13.8	0.5539
CHSW	1.42	2.33	2.16	3.00	2.84	3.99	1.30	2.57	2.30	**0.0046**	2.8	-4.6	10.7	0.4577
CLSW	0.19	0.04	0.46	1.18	0.92	1.85	0.42	0.13	1.78	**0.0001**	**29.9**	11.6	51.2	**0.0018**
COGR	1.92	2.18	1.82	7.48	6.32	1.39	2.20	2.44	3.50	**<0.0001**	-0.5	-5.7	5.0	0.8453
COMO	3.06	2.05	2.48	2.58	1.84	1.58	1.79	1.93	1.97	0.1020	**-4.9**	-8.9	-0.7	**0.0212**
CONI	1.05	1.97	2.77	1.01	0.79	0.33	0.13	0.40	1.00	**0.0452**	-8.1	-21.9	8.1	0.2984
COSN	0.76	0.31	0.38	0.64	0.77	0.19	0.11	0.33	0.23	**0.0174**	-10.0	-19.8	1.1	0.0862
COYE	2.48	2.78	2.74	3.14	3.06	3.41	2.93	3.28	3.25	0.0568	**3.0**	0.9	5.1	**0.0044**
EAKI	0.99	1.31	1.04	1.26	0.98	1.15	1.27	0.89	0.98	0.3475	-1.5	-5.4	2.5	0.4557
FOTE	0.53	0.49	1.20	0.70	0.13	0.20	0.65	0.24	0.17	**0.0404**	-11.0	-24.1	4.3	0.0941
GADW	0.29	1.67	0.70	0.54	0.57	0.00	0.00	1.40	0.60	0.1209	2.6	-14.0	22.4	0.7712
GBHE	0.79	0.98	0.90	0.87	0.70	0.77	1.08	1.31	1.58	**0.0007**	**8.2**	3.4	13.3	**0.0008**
GRHE	0.42	0.93	0.64	0.60	0.53	0.65	0.60	0.42	0.64	0.3641	-1.4	-7.8	5.4	0.6809
GWTE	0.04	0.04	0.26	0.88	0.55	0.92	0.66	0.27	0.29	**0.0100**	**32.9**	6.2	66.4	**0.0078**
LEBI	1.14	0.90	0.73	0.90	0.67	0.73	0.58	0.45	0.60	0.2462	**-8.5**	-14.2	-2.5	**0.0062**
MALL	2.43	1.70	2.33	3.17	3.66	1.93	2.73	3.11	6.48	**<0.0001**	**13.4**	8.5	18.6	**<0.0001**
MAWR	4.99	4.29	4.63	5.84	4.50	4.39	3.55	3.72	3.76	**<0.0001**	**-3.8**	-5.8	-1.7	**0.0003**
MOOT	8.39	7.70	6.36	7.76	4.38	5.35	4.30	6.25	5.38	**0.0003**	**-5.8**	-8.9	-2.5	**0.0005**
MUSW	2.29	3.53	2.28	1.92	2.70	1.83	1.64	1.79	2.44	0.3265	-5.4	-11.3	0.8	0.0864
NOHA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1327	-12.1	-27.3	6.2	0.1794
NRWS	1.13	1.01	0.57	1.46	1.50	0.72	2.01	1.46	1.95	**0.0213**	**10.3**	0.5	20.9	**0.0387**
PBGR	2.78	2.81	1.98	2.88	1.51	1.49	1.00	1.17	1.51	**<0.0001**	**-11.2**	-15.5	-6.8	**<0.0001**
PUMA	5.47	4.13	5.20	3.60	3.48	2.26	4.50	2.66	3.15	0.2352	-6.7	-13.2	0.3	0.0506
RWBL	17.91	21.03	16.93	17.23	16.70	15.95	15.93	14.24	17.61	**<0.0001**	**-2.6**	-3.9	-1.2	**0.0002**
SACR	0.79	0.64	0.46	0.49	0.18	0.94	0.92	0.61	1.24	0.5258	8.9	-6.6	26.9	0.2676
SEWR	1.83	1.88	0.90	0.92	0.42	1.10	0.81	0.66	0.50	0.0583	**-13.9**	-23.8	-2.8	**0.0166**
SORA	0.85	1.08	1.40	1.02	0.84	0.33	0.53	1.27	0.63	**<0.0001**	**-6.2**	-10.9	-1.4	**0.0098**
SOSP	2.67	2.22	2.36	2.51	2.49	2.94	2.71	2.45	2.82	0.1297	1.7	-0.5	3.9	0.1281
SWSP	4.70	4.58	4.68	4.66	4.84	4.92	4.30	4.14	4.52	0.5706	-0.9	-2.6	0.8	0.2984
TRES	20.76	17.41	16.57	18.38	12.32	13.27	13.28	13.10	13.90	**0.0019**	**-5.2**	-7.9	-2.4	**0.0003**
VIRA	2.34	1.97	2.40	2.58	1.87	1.64	1.71	2.00	1.50	**0.0003**	**-4.5**	-7.0	-1.9	**0.0008**
WIFL	0.92	0.70	0.99	0.95	1.26	1.11	1.31	1.20	1.18	0.4710	**5.2**	0.1	10.6	**0.0477**
YWAR	3.28	3.77	3.08	3.30	3.45	3.53	3.51	3.99	3.76	0.1008	**1.8**	0.0	3.7	**0.0484**

* See Appendix 1 for common and latin names associated with each species code.
p^1 - probability that significant year-to-year variation in abundance index occurred.
p^2 - probability that abundance index trend between 1995-2003 differed significantly from zero.
Bold indicates statistical significance at $p < 0.05$.

Table 5b. Annual abundance indices and trends in marsh bird populations within the Lake Michigan basin, 1995-2003 *.

	Annual Abundance Indices													
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
BARS	8.96	6.86	6.07	6.56	11.92	10.53	10.58	6.51	5.82	0.2852	1.5	-5.9	9.6	0.6898
BEKI	0.18	0.84	0.33	0.48	0.75	0.30	0.49	0.18	0.50	0.7316	-3.3	-17.3	12.9	0.6745
CAGO	1.95	3.91	1.34	19.02	25.59	8.83	8.06	3.54	4.67	**<0.0001**	-0.2	-11.6	12.8	0.9764
COGR	1.34	1.41	1.03	2.41	3.29	1.76	0.92	2.92	2.73	0.2582	8.9	-3.2	22.5	0.1634
COYE	3.82	3.05	3.42	5.39	5.12	5.41	4.42	5.52	5.00	**0.0400**	**5.4**	0.9	10.0	**0.0188**
EAKI	1.32	0.90	0.76	0.66	1.78	2.57	0.68	0.86	0.80	0.0754	0.6	-11.0	13.7	0.9137
GBHE	1.12	0.99	0.83	1.17	1.85	0.54	0.88	0.61	1.27	0.5196	0.0	-11.5	13.1	0.9951
GRHE	0.79	1.32	0.74	0.91	1.79	0.64	0.31	0.22	0.60	0.6926	-8.9	-24.2	9.4	0.3617
MALL	1.83	0.45	0.63	3.37	3.36	1.70	2.35	3.05	4.67	**0.0002**	**23.4**	11.2	37.0	**0.0002**
MAWR	3.51	2.12	3.06	3.79	4.26	4.84	2.45	4.32	3.30	**0.0254**	2.0	-3.2	7.6	0.4416
MOOT	11.14	7.73	1.36	2.35	2.42	1.29	0.54	7.72	1.00	**<0.0001**	**-11.7**	-23.9	2.6	**0.0266**
NRWS	0.00	0.00	0.33	0.00	0.00	0.68	0.78	1.16	1.00	0.0608	**46.8**	-6.4	130.4	**0.0328**
PBGR	2.71	3.26	1.26	3.83	2.44	2.41	0.58	2.79	0.33	**0.0007**	**-15.7**	-25.4	-4.8	**0.0029**
RWBL	22.26	18.17	17.66	18.48	18.97	15.51	16.46	15.84	17.00	0.2865	-2.5	-5.1	0.1	0.0555
SACR	1.15	0.54	0.80	0.42	0.48	0.00	0.72	0.40	1.78	0.1934	8.8	-11.0	33.1	0.3800
SORA	1.79	1.00	0.77	0.71	0.76	0.21	0.52	2.73	0.10	**0.0024**	-12.3	-25.5	3.3	0.0695
SOSP	4.29	3.02	3.14	4.00	3.40	3.91	3.96	3.78	3.92	0.9418	2.2	-4.0	8.7	0.5050
SWSP	4.68	4.23	4.09	5.14	4.48	4.35	4.56	4.47	4.00	0.9829	-0.5	-5.1	4.3	0.8300
TRES	30.51	31.20	10.45	28.05	14.02	25.77	17.98	8.76	10.43	**<0.0001**	**-11.1**	-17.0	-4.9	**0.0001**
VIRA	1.75	1.36	1.81	1.82	2.05	0.77	1.20	1.88	0.89	0.0931	-5.8	-13.0	2.0	0.1290
WIFL	0.89	0.19	0.58	0.36	0.79	0.53	1.67	0.90	0.75	0.3273	11.6	-4.0	29.7	0.1710
YWAR	4.13	3.64	2.91	2.98	3.66	2.80	3.33	5.12	4.45	0.3264	3.3	-1.8	8.6	0.2054

* See Appendix 1 for common and latin names associated with each species code.

p^1 - probability that significant year-to-year variation in abundance index occurred.

p^2 - probability that abundance index trend between 1995-2003 differed significantly from zero.

Bold indicates statistical significance at $p < 0.05$.

Table 5c. Annual abundance indices and trends in marsh bird populations within the Lake Huron basin, 1995-2003 *.

	Annual Abundance Indices													
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
AMBI	0.34	0.55	0.61	0.43	0.36	0.24	0.34	0.52	0.44	0.8109	-3.7	-15.3	9.6	0.5590
AMCO	2.85	4.13	0.51	3.53	1.27	2.69	2.50	2.10	1.29	**0.0351**	-7.4	-16.5	2.7	0.1257
BARS	1.51	1.40	3.18	2.84	3.06	3.16	3.91	1.80	0.75	0.3364	2.2	-8.1	13.7	0.6902
BEKI	0.73	0.43	0.19	0.23	0.50	0.37	0.12	0.44	0.67	0.5535	2.2	-13.4	20.6	0.7918
BLTE	30.21	18.92	14.02	22.09	6.99	5.78	6.30	9.68	4.14	**<0.0001**	**-21.3**	-28.2	-13.7	**<0.0001**
BWTE	2.21	1.62	2.45	3.21	1.05	1.21	0.99	0.41	0.75	0.0541	**-15.2**	-24.8	-4.4	**0.0042**
CAGO	19.18	5.87	3.05	2.31	2.88	5.21	2.45	8.12	0.82	**0.0015**	-11.8	-23.0	1.2	0.0543
CATE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4540	-1.0	-13.3	13.1	0.8816
COGR	0.97	4.05	0.14	1.20	6.92	0.08	1.25	0.29	1.17	**<0.0001**	-9.9	-23.8	6.4	0.1232
COMO	3.14	1.05	2.95	2.76	2.17	0.78	1.76	1.25	2.17	0.3349	-6.2	-15.5	4.0	0.2295
COSN	0.79	0.44	0.50	0.67	0.68	0.19	0.00	0.53	0.13	**0.0476**	**-13.7**	-25.0	-0.7	**0.0315**
COYE	1.09	1.46	1.89	2.31	2.03	2.23	2.01	1.59	2.17	0.4107	4.3	-1.7	10.6	0.1633
EAKI	1.44	1.10	1.06	1.79	1.02	0.86	1.09	1.00	0.83	0.6948	-5.6	-13.2	2.6	0.1851
GBHE	0.55	0.57	0.54	0.69	0.61	1.08	0.90	0.56	0.75	0.9601	4.2	-6.7	16.4	0.4913
LEBI	1.76	1.35	0.79	0.65	1.50	1.89	0.32	0.15	1.00	**0.0008**	**-10.8**	-20.6	0.3	**0.0135**
MALL	4.12	1.71	2.01	1.88	1.29	1.15	1.26	1.51	0.55	**0.0164**	**-15.7**	-23.4	-7.2	**0.0003**
MAWR	2.60	3.18	2.86	4.38	3.41	3.42	2.89	3.88	2.73	0.6236	0.8	-4.6	6.5	0.7849
MOOT	9.39	8.24	6.50	9.85	7.03	5.43	6.39	5.32	4.90	0.3150	**-7.4**	-12.9	-1.6	**0.0139**
PBGR	4.25	3.13	3.31	3.98	2.52	1.14	1.47	1.28	3.25	**0.0095**	**-10.5**	-17.6	-2.8	**0.0038**
RWBL	9.73	12.23	10.02	10.19	13.08	8.35	7.69	4.48	8.13	**<0.0001**	**-7.9**	-11.3	-4.4	**<0.0001**
SORA	1.18	1.79	2.10	1.50	1.38	0.21	0.70	1.06	1.30	**0.0124**	**-7.8**	-15.3	0.3	**0.0461**
SOSP	1.64	0.56	1.03	1.53	1.51	1.62	1.75	0.73	1.25	**0.0230**	1.5	-5.7	9.3	0.6774
SWSP	2.73	2.47	2.64	2.62	3.19	2.41	2.49	2.30	2.79	0.9222	-0.7	-5.2	4.0	0.7647
TRES	16.68	7.68	19.92	14.96	7.50	6.69	3.77	7.39	3.21	**<0.0001**	**-16.3**	-22.5	-9.6	**<0.0001**
VIRA	2.65	2.61	3.17	3.92	3.04	2.33	2.02	1.85	1.92	**0.0204**	**-5.7**	-9.9	-1.3	**0.0108**
YWAR	1.33	1.62	1.14	1.73	1.36	2.31	2.03	2.02	2.00	0.2094	**6.9**	0.8	13.4	**0.0238**

* See Appendix 1 for common and latin names associated with each species code.

p^1 - probability that significant year-to-year variation in abundance index occurred.

p^2 - probability that abundance index trend between 1995-2003 differed significantly from zero.

Bold indicates statistical significance at $p < 0.05$.

Table 5d. Annual abundance indices and trends in marsh bird populations within the Lake Huron-Michigan basins, 1995-2003 *.

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
	Annual Abundance Indices													
ALFL	1.85	0.00	0.25	0.24	0.62	0.62	0.11	0.40	0.33	0.1432	-12.0	-31.2	12.4	0.2797
AMBI	0.46	0.65	0.55	0.41	0.31	0.22	0.31	0.52	0.44	0.6154	-5.7	-16.5	6.5	0.3270
AMCO	2.69	3.91	0.62	2.75	1.39	1.82	1.59	3.07	0.92	**0.0010**	-7.5	-15.6	1.3	0.0648
BANS	1.08	0.39	10.31	11.76	0.76	0.38	3.64	1.05	0.88	0.0502	-2.0	-19.3	19.0	0.8635
BARS	5.14	4.32	5.13	5.00	8.00	7.45	7.88	4.42	3.68	0.0787	1.7	-4.2	8.1	0.5752
BEKI	0.44	0.67	0.26	0.35	0.62	0.36	0.30	0.35	0.57	0.5860	-0.7	-11.2	11.1	0.9065
BLTE	26.10	16.64	12.35	17.37	6.20	5.99	5.02	7.86	4.45	**<0.0001**	**-20.4**	-26.4	-14.0	**<0.0001**
BWTE	2.66	1.56	2.38	2.86	1.32	0.76	0.91	0.50	0.83	**0.0296**	**-16.0**	-24.9	-6.2	**0.0011**
CAGO	21.65	3.41	2.02	8.45	8.73	7.29	4.97	9.71	2.55	**0.0003**	-5.9	-14.4	3.4	0.1832
CATE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4008	-2.9	-14.7	10.5	0.6365
CHSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.3558	-26.9	-50.2	7.3	0.0672
COGR	1.15	2.12	0.43	2.15	7.24	0.45	1.16	0.56	1.91	**<0.0001**	-3.7	-13.6	7.4	0.4199
COMO	2.12	1.00	1.77	1.83	1.40	0.41	1.09	0.78	1.27	0.1565	-8.7	-16.6	-0.1	0.0510
COSN	0.85	0.39	0.39	0.64	0.82	0.22	0.09	0.53	0.13	0.0806	-12.2	-22.9	0.1	0.0578
COYE	2.24	2.28	2.78	3.90	3.58	3.83	3.27	3.30	3.58	**0.0211**	**4.9**	1.1	8.7	**0.0097**
EAKI	1.41	1.01	0.93	1.17	1.26	1.40	0.95	0.93	0.82	0.7609	-3.4	-9.9	3.6	0.3327
GBHE	0.76	0.78	0.68	0.93	1.13	0.77	0.91	0.63	1.05	0.8824	2.1	-5.9	10.8	0.6140
GRHE	0.56	1.44	0.65	0.52	0.96	0.41	0.38	0.15	0.50	0.2977	-10.9	-23.7	4.1	0.1534
LEBI	1.37	1.01	0.57	0.51	0.95	1.27	0.28	0.19	0.82	**0.0186**	**-9.6**	-18.3	0.1	**0.0401**
MALL	4.90	1.11	1.23	2.74	1.91	1.41	1.74	2.03	2.70	**0.0006**	0.8	-6.1	8.2	0.8140
MAWR	2.96	2.90	2.92	4.14	3.76	3.86	2.75	4.06	3.00	0.1012	1.2	-2.6	5.1	0.5392
MOOT	7.55	7.47	4.43	7.02	5.25	3.77	4.24	5.74	3.17	**0.0269**	**-8.1**	-13.1	-2.7	**0.0026**
NRWS	1.01	0.83	1.07	0.94	0.00	0.99	0.77	0.70	0.57	0.8874	-6.4	-27.2	20.4	0.6032
PBGR	3.73	3.15	2.54	3.81	2.44	1.64	1.10	1.46	2.00	**0.0020**	**-11.8**	-17.5	-5.6	**0.0001**
PUMA	4.70	3.86	0.79	2.02	0.00	1.62	2.10	1.32	0.33	**0.0044**	**-22.7**	-37.9	-3.8	**0.0030**
RWBL	15.95	16.05	14.47	14.98	17.67	12.20	12.21	8.08	12.41	**<0.0001**	**-5.7**	-7.9	-3.4	**<0.0001**
SACR	1.15	0.78	0.48	0.32	0.27	0.92	0.57	0.33	1.33	0.5929	2.5	-14.2	22.5	0.7842
SEWR	0.63	0.75	0.26	0.34	0.35	0.27	0.11	0.13	0.17	0.6826	-18.1	-32.5	-0.7	0.0503
SORA	1.40	1.35	1.46	1.15	1.14	0.24	0.65	1.40	0.70	**0.0018**	**-9.1**	-15.9	-1.7	**0.0109**
SOSP	3.11	1.70	2.13	2.87	2.70	2.96	3.08	2.08	2.58	0.0745	1.9	-2.9	6.9	0.4336
SWSP	3.51	3.18	3.27	3.56	3.83	3.15	3.27	3.11	3.26	0.9303	-0.6	-3.9	2.7	0.7089
TRES	27.87	18.29	18.12	23.34	11.41	15.19	9.89	9.44	6.82	**<0.0001**	**-13.6**	-17.9	-9.0	**<0.0001**
VIRA	2.32	2.12	2.68	3.10	2.73	1.62	1.73	1.79	1.50	**0.0011**	**-5.7**	-9.3	-1.9	**0.0028**
WIFL	0.76	0.31	0.45	0.32	0.52	0.46	1.08	1.01	0.70	0.3452	10.7	-1.8	24.7	0.1078
YWAR	2.45	2.45	1.96	2.32	2.36	2.71	2.75	3.30	3.08	0.2555	**5.0**	1.1	9.2	**0.0127**

* See Appendix 1 for common and latin names associated with each species code.

p^1 - probability that significant year-to-year variation in abundance index occurred.

p^2 - probability that abundance index trend between 1995-2003 differed significantly from zero.

Bold indicates statistical significance at $p < 0.05$.

Table 5e. Annual abundance indices and trends in marsh bird populations throughout the Lake Erie basin, 1995-2003 *.

Species	Annual Abundance Indices													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
AMBI	0.39	0.70	1.60	1.99	0.45	0.55	0.17	0.27	0.20	0.0791	-15.9	-29.5	0.2	0.0754
AMCO	1.17	27.75	13.11	29.96	0.48	3.70	0.70	2.47	3.63	**<0.0001**	-3.7	-18.0	13.2	0.6211
BANS	19.53	9.71	2.47	3.83	10.54	1.41	5.88	3.90	1.91	**<0.0001**	**-15.8**	-26.3	-3.7	**0.0038**
BARS	5.40	6.25	4.21	5.21	5.08	4.59	6.12	5.26	6.05	0.5944	1.1	-3.7	6.1	0.6619
BCNH	0.00	0.05	0.25	0.50	0.02	0.61	0.16	1.20	1.00	**<0.0001**	**38.2**	7.7	77.4	**0.0001**
BEKI	0.33	0.70	0.68	0.49	0.25	0.81	0.70	0.30	0.62	0.1729	1.5	-9.0	13.1	0.7852
BLTE	1.80	2.15	2.98	1.51	0.97	1.59	2.20	1.14	1.17	0.3684	-5.9	-14.9	4.1	0.2526
BWTE	0.55	1.04	0.43	0.41	0.60	0.36	0.97	0.53	1.00	0.9256	5.8	-13.5	29.4	0.6016
CAGO	1.31	5.56	3.96	8.48	5.88	5.28	4.29	5.64	2.62	**0.0194**	-1.1	-9.3	7.9	0.8011
CHSW	2.01	2.99	2.34	4.23	3.29	5.25	1.84	2.28	2.09	0.0908	-7.2	-17.6	4.5	0.2020
CLSW	0.19	0.07	0.00	0.23	0.34	0.14	0.12	0.16	0.80	0.3898	25.4	-7.6	70.2	0.1163
COGR	4.39	5.50	5.19	11.10	9.55	3.06	5.04	1.72	5.33	**<0.0001**	**-7.1**	-13.9	0.2	**0.0337**
COMO	1.99	1.70	0.96	0.90	0.50	0.84	1.11	0.59	0.50	0.1905	**-14.5**	-24.1	-3.7	**0.0133**
COYE	3.38	4.11	3.30	3.56	3.46	4.29	3.70	4.05	4.00	0.4644	1.8	-1.2	5.0	0.2508
EAKI	1.26	1.46	1.35	1.90	0.78	1.42	1.87	1.17	1.52	**0.0264**	1.2	-4.9	7.6	0.7031
FOTE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0355**	-11.2	-25.0	5.1	0.1001
GBHE	1.15	1.57	1.72	1.46	0.54	1.04	1.47	2.76	2.62	**<0.0001**	**13.8**	5.0	23.5	**0.0015**
GRHE	0.37	1.70	1.03	1.07	0.75	0.93	1.13	0.59	1.08	0.2899	0.9	-8.3	11.1	0.8571
LEBI	1.67	1.08	1.65	2.94	0.53	0.76	0.93	0.87	0.89	0.0833	-8.2	-18.6	3.6	0.1586
MALL	6.31	5.97	4.23	5.54	3.40	2.58	4.36	4.58	14.65	**<0.0001**	**19.8**	10.9	29.3	**<0.0001**
MAWR	6.48	5.41	5.15	6.60	4.56	3.93	3.55	2.73	3.07	**<0.0001**	**-9.5**	-12.6	-6.3	**<0.0001**
MOOT	12.61	12.02	7.20	9.94	1.90	6.10	3.38	3.74	6.18	**0.0002**	**-12.5**	-20.2	-4.2	**0.0046**
NRWS	2.28	1.78	0.50	1.06	2.20	0.86	3.06	3.04	2.79	0.0699	11.3	-3.4	28.2	0.1703
PBGR	0.98	2.48	2.39	1.77	0.68	1.59	1.09	1.17	1.50	0.0700	-2.6	-12.5	8.4	0.6210
PUMA	12.97	6.02	3.62	5.61	4.65	3.19	7.27	4.86	5.00	**0.0076**	-5.4	-12.7	2.5	0.1428
RWBL	22.16	25.31	17.70	17.15	14.42	18.21	17.97	17.26	19.50	**<0.0001**	**-3.1**	-5.2	-1.0	**0.0022**
SORA	0.36	1.61	2.24	2.26	0.89	0.39	0.14	1.32	0.45	**0.0003**	-11.9	-21.5	-1.1	0.0514
SOSP	3.27	2.43	2.53	2.53	2.56	3.48	2.94	3.18	3.59	**0.0384**	**3.4**	0.0	6.8	**0.0447**
SWSP	5.79	6.49	6.02	5.69	5.39	6.20	4.64	4.47	5.53	0.0994	**-3.1**	-5.7	-0.5	**0.0214**
TRES	38.43	26.47	20.88	18.31	15.33	15.79	19.74	18.79	28.36	**0.0001**	-2.7	-7.4	2.2	0.2456
VIRA	1.81	1.61	1.49	0.97	0.88	0.71	0.79	1.45	0.42	**0.0009**	**-10.7**	-16.0	-5.0	**0.0003**
WIFL	0.67	0.67	1.22	0.85	0.84	1.14	1.41	1.34	1.62	0.3702	**10.0**	1.5	19.3	**0.0235**
YWAR	3.33	4.64	3.84	3.52	4.26	4.16	4.14	4.79	4.72	0.1541	**3.1**	0.1	6.1	**0.0420**

* See Appendix 1 for common and latin names associated with each species code.

p^1 - probability that significant year-to-year variation in abundance index occurred.

p^2 - probability that abundance index trend between 1995-2003 differed significantly from zero.

Bold indicates statistical significance at $p < 0.05$.

Table 5f. Annual abundance indices and trends in marsh bird populations within the Lake Ontario basin, 1995-2003*.

	Annual Abundance Indices													
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
ALFL	0.55	1.21	0.57	1.16	0.87	1.04	0.99	0.88	0.75	0.9501	0.8	-10.7	13.7	0.8989
AMBI	0.48	0.81	0.90	1.36	0.15	1.08	0.65	0.22	0.20	**0.0395**	-10.1	-23.8	6.0	0.1992
BANS	3.62	2.31	5.33	2.90	3.61	1.73	3.16	7.89	4.25	0.0513	4.9	-5.0	15.9	0.2909
BARS	4.57	4.63	4.54	5.26	4.47	4.35	3.68	4.06	5.88	0.8663	0.6	-4.6	6.2	0.8170
BCNH	0.76	1.70	1.49	1.26	0.59	0.61	0.61	0.78	0.90	0.8447	-4.8	-16.3	8.4	0.4701
BEKI	0.44	0.37	0.48	0.49	0.30	0.27	0.36	0.30	0.89	0.3284	4.0	-5.8	14.8	0.4514
BLTE	5.06	4.27	0.97	3.94	2.44	1.34	2.75	1.38	1.27	**0.0155**	**-14.0**	-24.0	-2.7	**0.0127**
BWTE	1.34	1.30	0.72	1.00	0.30	1.31	0.88	0.62	0.63	0.2638	-10.1	-20.8	2.1	0.0883
CAGO	3.52	3.61	6.26	5.03	3.10	2.14	5.38	2.02	2.78	0.3569	-4.6	-13.4	5.0	0.3301
CATE	0.21	0.43	0.68	0.51	0.11	0.14	0.71	0.67	1.67	0.2140	18.0	-2.1	42.3	0.0730
CHSW	0.80	1.16	1.39	1.47	1.77	2.31	1.18	3.98	3.55	**0.0050**	**21.3**	10.6	33.0	**0.0001**
CLSW	0.12	0.00	0.32	0.84	0.75	1.50	0.10	0.00	4.50	**0.0003**	**71.1**	19.2	145.7	**0.0003**
COGR	1.41	0.87	1.60	7.13	1.92	1.26	1.01	6.39	3.22	**<0.0001**	7.4	-2.9	18.8	0.0732
COMO	3.23	2.54	3.63	3.81	3.01	2.57	2.27	3.63	3.00	0.3935	-0.5	-5.5	4.6	0.8314
COYE	1.72	2.12	2.31	2.38	2.59	2.28	1.95	2.44	2.35	0.5911	2.9	-1.4	7.4	0.1901
EAKI	0.53	1.46	0.94	0.92	1.16	0.79	1.04	0.54	0.65	0.1272	-3.6	-11.0	4.4	0.3691
GADW	0.41	2.16	0.78	0.70	1.05	0.00	0.00	1.65	0.50	0.2308	0.6	-16.0	20.5	0.9443
GBHE	0.62	0.55	0.65	0.56	0.68	0.77	1.32	0.68	1.05	0.3500	7.3	-0.3	15.5	0.0652
GRHE	0.41	0.37	0.39	0.41	0.27	0.72	0.25	0.50	0.40	0.8788	1.4	-10.3	14.5	0.8362
LEBI	0.62	0.73	0.52	0.30	0.74	0.57	0.62	0.41	0.27	0.6573	-6.6	-16.6	4.6	0.2586
MALL	2.20	1.71	2.69	2.73	2.13	2.60	2.53	2.87	1.79	0.7217	0.8	-5.7	7.9	0.8078
MAWR	5.08	4.28	6.05	6.86	5.39	5.17	4.20	4.85	4.87	0.1737	-1.3	-4.9	2.5	0.4990
MOOT	7.99	7.75	8.64	8.93	6.87	5.88	5.75	8.97	7.53	0.4836	-1.3	-5.7	3.4	0.5861
MUSW	0.77	0.90	0.97	0.64	1.27	0.97	0.76	0.93	1.60	0.7956	6.1	-3.9	17.2	0.2554
NRWS	0.81	0.38	0.58	2.20	1.10	0.32	1.61	0.51	1.93	**0.0038**	**14.0**	-1.7	32.2	**0.0479**
PBGR	3.06	2.19	1.35	2.44	1.51	0.84	0.56	0.86	0.78	**0.0141**	**-17.1**	-25.4	-7.9	**0.0005**
PUMA	1.24	1.88	7.06	1.83	2.92	1.55	0.00	0.13	2.25	**0.0009**	-5.2	-20.6	13.3	0.4340
RWBL	16.59	22.20	19.51	20.97	20.23	18.62	18.63	19.00	21.68	0.4605	0.5	-2.1	3.3	0.6973
SORA	0.44	0.66	0.84	0.48	0.52	0.33	0.66	1.17	0.44	0.1145	1.1	-7.6	10.5	0.8141
SOSP	2.38	2.72	2.70	2.34	2.58	2.56	2.55	2.01	2.30	0.8622	-1.6	-5.0	2.0	0.3931
SWSP	5.31	4.71	5.26	5.14	5.89	6.19	5.77	5.54	5.48	0.7865	1.7	-1.3	4.8	0.2699
TRES	7.66	8.47	11.50	13.17	11.33	12.87	14.65	10.49	8.10	0.1387	2.2	-2.9	7.6	0.3854
VIRA	2.18	1.76	2.61	3.21	1.78	2.52	2.31	2.44	2.08	**0.0488**	0.5	-3.9	5.2	0.8143
WIFL	1.42	1.06	1.01	1.73	2.65	1.59	1.23	1.31	1.09	0.1979	-0.3	-7.7	7.8	0.9486
YWAR	4.16	4.54	3.54	4.29	3.91	3.78	3.76	4.12	3.81	0.7910	-1.1	-4.0	1.8	0.4483

* See Appendix 1 for common and latin names associated with each species code.

p^1 - probability that significant year-to-year variation in abundance index occurred.

p^2 - probability that abundance index trend between 1995-2003 differed significantly from zero.

Bold indicates statistical significance at $p < 0.05$.

Table 6a. Annual occurrence indices and trends in calling amphibian populations throughout the Great Lakes basin, 1995-2003 *.

	Annual Occurrence Indices													
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
AMTO	48.69	49.46	46.38	47.93	40.54	41.29	42.98	43.07	44.49	0.5644	-0.8	-1.8	0.2	0.1206
BULL	61.44	55.21	54.48	63.66	58.62	44.20	50.57	55.96	38.50	**0.0038**	**-1.6**	-2.9	-0.3	**0.0144**
CGTR	0.00	2.24	2.57	16.13	26.36	39.65	18.21	40.29	7.69	**0.0000**	**1.3**	0.2	2.6	**0.0175**
CHFR	65.31	51.88	53.72	47.94	45.76	38.21	42.88	49.95	37.72	**0.0102**	**-1.9**	-3.1	-0.6	**0.0041**
FOTO	5.62	29.79	34.64	35.29	31.01	33.46	43.79	46.35	15.91	0.0720	0.5	-1.0	2.1	0.5556
GRFR	66.50	66.45	70.62	85.20	59.26	53.42	61.31	62.21	55.63	**<0.0001**	**-2.3**	-3.4	-1.3	**<0.0001**
GRTR	39.73	61.13	50.76	48.04	44.07	51.86	50.40	61.24	60.67	**0.0014**	**1.4**	0.2	2.6	**0.0226**
MIFR	18.28	15.04	7.43	5.05	11.80	37.92	18.94	3.88	19.05	0.3916	0.6	-3.0	4.8	0.7525
NLFR	34.20	49.31	51.71	68.56	40.94	42.80	33.07	33.41	43.64	**<0.0001**	**-1.4**	-2.6	-0.2	**0.0223**
PIFR	3.35	15.32	15.80	12.43	19.89	29.76	31.62	14.73	9.52	**0.0285**	0.4	-0.8	1.6	0.5437
SPPE	52.52	63.70	73.66	80.26	60.32	55.90	62.27	83.61	76.00	**<0.0001**	**1.3**	0.1	2.4	**0.0273**
WOFR	30.17	41.68	29.47	33.07	34.52	26.43	33.96	35.51	26.76	0.1577	-0.4	-1.4	0.7	0.4759

* See Appendix 2 for common and latin names associated with each species code.
p^1 - probability that significant year-to-year variation in occurrence index occurred.
p^2 - probability that occurrence index trend between 1995-2003 differed significantly from zero.
Bold indicates statistical significance at $p < 0.05$.

Table 6b. Annual occurrence indices and trends in calling amphibian populations within the Lake Michigan basin, 1995-2003 *.

	Annual Occurrence Indices													
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
AMTO	50.95	64.47	50.56	41.14	39.34	45.92	45.98	40.11	28.21	0.1175	**-2.1**	-3.8	-0.4	**0.0164**
BULL	13.58	23.28	12.06	23.80	41.91	2.88	32.92	22.45	10.00	**0.0058**	-0.5	-1.8	1.0	0.4567
CGTR	0.00	0.00	0.00	0.00	7.94	14.00	11.36	23.33	10.00	**0.0002**	**5.4**	2.0	9.6	**0.0003**
CHFR	92.39	69.81	71.71	63.98	55.03	56.35	57.70	67.04	64.10	0.0818	-1.5	-3.8	0.8	0.2061
GRFR	47.73	47.77	58.40	83.91	57.52	35.98	62.07	52.98	39.74	**<0.0001**	**-2.8**	-4.8	-0.7	**0.0087**
GRTR	41.17	92.65	69.38	70.52	71.30	68.85	77.01	80.61	67.95	**0.0019**	0.4	-1.7	2.3	0.7130
NLFR	23.54	18.63	16.01	25.54	24.99	12.39	6.59	17.15	21.28	0.1300	-1.1	-3.1	1.2	0.3413
SPPE	89.82	93.90	94.22	88.25	86.09	84.12	80.14	98.13	88.16	0.0559	-0.6	-2.2	0.8	0.4186
WOFR	23.21	23.40	21.71	24.11	36.31	22.86	32.83	39.83	19.48	0.1440	0.6	-0.9	2.2	0.4658

* See Appendix 2 for common and latin names associated with each species code.
p^1 - probability that significant year-to-year variation in occurrence index occurred.
p^2 - probability that occurence index trend between 1995-2003 differed significantly from zero.
Bold indicates statistical significance at $p < 0.05$.

Table 6c. Annual occurrence indices and trends in calling amphibian populations within the Lake Huron basin, 1995-2003 *.

Species	Annual Occurrence Indices									p [1]	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p [2]
	1995	1996	1997	1998	1999	2000	2001	2002	2003					
AMTO	60.98	51.52	61.34	56.74	48.93	28.49	30.05	34.78	34.78	**0.0029**	**-4.2**	-6.2	-2.2	**0.0001**
BULL	5.46	31.64	15.02	21.24	45.01	70.89	70.31	38.48	36.84	**0.0012**	**4.5**	1.2	7.8	**0.0060**
CHFR	81.40	51.55	67.16	29.43	50.98	23.45	21.99	34.02	13.95	**<0.0001**	**-3.2**	-4.4	-1.9	**<0.0001**
GRFR	75.60	82.92	86.60	96.98	66.08	58.32	57.38	53.29	61.67	**<0.0001**	**-7.3**	-10.1	-4.4	**<0.0001**
GRTR	67.49	51.03	48.13	40.31	39.35	49.90	46.46	58.13	58.62	0.4336	1.0	-1.3	3.2	0.4113
NLFR	44.51	66.62	58.66	70.73	56.25	56.45	60.75	30.56	38.46	0.1381	-2.5	-5.3	0.3	0.0777
SPPE	91.36	94.24	92.89	97.10	91.51	81.89	77.29	86.88	85.00	0.1009	**-2.5**	-4.7	-0.4	**0.0135**
WOFR	66.11	59.09	37.46	46.89	42.10	56.10	44.96	40.60	35.56	0.4799	-1.2	-3.4	1.0	0.2845

* See Appendix 2 for common and latin names associated with each species code.
p [1] - probability that significant year-to-year variation in occurrence index occurred.
p [2] - probability that occurrence index trend between 1995-2003 differed significantly from zero.
Bold indicates statistical significance at $p < 0.05$.

Table 6d. Annual occurrence indices and trends in calling amphibian populations within the Lake Huron-Michigan basins, 1995-2003 *.

Species	Annual Occurrence Indices									p [1]	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p [2]
	1995	1996	1997	1998	1999	2000	2001	2002	2003					
AMTO	56.70	57.98	55.99	47.00	43.92	40.45	38.86	37.68	30.65	**0.0046**	**-3.1**	-4.3	-1.7	**<0.0001**
BULL	8.92	25.93	11.76	24.95	43.16	24.23	50.95	30.72	21.59	**0.0005**	1.5	-0.3	3.4	0.0979
CGTR	0.00	0.00	3.17	17.17	24.66	26.54	18.30	25.45	6.82	**0.0016**	1.1	-0.1	2.5	0.0770
CHFR	89.78	64.91	71.58	53.32	53.42	45.51	43.52	54.30	46.28	**0.0001**	**-3.7**	-5.6	-1.8	**0.0001**
GRFR	61.84	65.74	74.06	90.71	63.63	47.60	61.56	53.83	49.28	**<0.0001**	**-4.7**	-6.4	-2.9	**<0.0001**
GRTR	55.63	75.40	61.65	59.40	58.55	61.05	64.89	72.03	63.97	0.1807	0.6	-0.9	2.1	0.4027
NLFR	34.93	41.87	34.96	47.55	41.77	30.06	27.19	22.31	29.07	0.1906	-1.8	-3.5	0.0	0.0513
PIFR	1.64	9.08	11.05	4.24	8.67	3.43	20.28	14.44	8.82	0.2901	0.9	-0.7	2.6	0.2873
SPPE	90.81	94.10	93.56	91.22	88.04	83.47	78.60	91.97	86.76	**0.0221**	**-1.4**	-2.7	-0.2	**0.0214**
WOFR	37.80	38.68	29.21	34.08	39.65	36.62	37.89	39.84	25.41	0.3381	-0.2	-1.4	1.2	0.8209

* See Appendix 2 for common and latin names associated with each species code.
p [1] - probability that significant year-to-year variation in occurrence index occurred.
p [2] - probability that occurrence index trend between 1995-2003 differed significantly from zero.
Bold indicates statistical significance at $p < 0.05$.

Table 6e. Annual occurrence indices and trends in calling amphibian populations within the Lake Erie basin, 1995-2003 *.

	Annual Occurrence Indices													
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
AMTO	26.47	39.79	24.55	37.47	20.67	30.93	33.52	37.53	52.44	**0.0014**	1.7	-0.1	3.5	0.0596
BULL	86.52	77.93	82.77	85.00	73.88	72.08	66.85	78.18	52.17	**0.0015**	**-3.3**	-5.2	-1.3	**0.0010**
CHFR	17.28	35.76	23.70	40.56	35.51	30.98	36.63	40.90	29.03	0.2373	1.4	-0.6	3.4	0.1871
GRFR	79.84	63.16	65.37	74.33	59.43	59.81	65.78	73.77	63.74	0.0629	-0.2	-2.0	1.5	0.8124
GRTR	20.35	36.85	41.62	33.16	23.27	41.72	30.68	35.29	39.62	0.1681	0.4	-1.9	2.7	0.7345
NLFR	51.75	73.76	76.67	88.23	49.31	58.32	32.50	44.39	47.30	**<0.0001**	**-4.6**	-6.6	-2.5	**<0.0001**
PIFR	0.00	44.93	22.34	43.17	31.93	43.76	52.67	17.74	15.00	0.1934	-0.8	-3.4	2.2	0.5702
SPPE	18.15	37.46	34.29	53.99	27.38	27.91	51.11	83.38	61.36	**<0.0001**	**5.6**	3.1	8.0	**<0.0001**
WOFR	13.54	49.33	20.63	22.98	29.12	15.22	27.09	28.37	30.95	0.0953	0.7	-1.9	3.4	0.5972

* See Appendix 2 for common and latin names associated with each species code.
p^1 - probability that significant year-to-year variation in occurrence index occurred.
p^2 - probability that occurence index trend between 1995-2003 differed significantly from zero.
Bold indicates statistical significance at $p < 0.05$.

Table 6f. Annual occurrence indices and trends in calling amphibian populations within the Lake Ontario basin, 1995-2003 *.

	Annual Occurrence Indices													
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	p^1	Trend (%/Yr)	Lower 95% C.I.	Upper 95% C.I.	p^2
AMTO	66.72	41.44	48.78	53.54	67.35	53.48	62.14	47.15	58.73	0.1364	0.3	-1.6	2.2	0.7464
BULL	78.98	71.50	75.40	76.17	79.52	26.44	46.75	64.06	51.16	**0.0025**	**-3.5**	-6.6	-0.4	**0.0253**
CHFR	81.30	50.73	50.59	40.04	32.63	25.01	39.47	50.11	26.67	**0.0241**	**-2.8**	-5.2	-0.3	**0.0296**
GRFR	51.17	70.76	71.11	85.80	49.06	54.13	56.12	55.53	56.96	**0.0362**	-1.3	-3.5	0.8	0.2174
GRTR	13.18	20.42	12.89	14.09	17.29	21.71	20.46	49.42	73.47	**0.0002**	**5.1**	2.5	7.4	**0.0001**
NLFR	22.12	34.90	43.11	62.06	36.31	41.63	49.42	35.93	58.11	**0.0137**	**2.4**	0.4	4.4	**0.0195**
SPPE	17.75	10.67	45.45	100.00	22.21	32.88	24.29	37.67	72.60	**<0.0001**	**3.1**	0.3	5.7	**0.0262**
WOFR	28.23	40.81	50.75	69.08	24.05	18.80	29.82	28.45	21.74	0.0954	-1.7	-3.5	0.2	0.0727

* See Appendix 2 for common and latin names associated with each species code.
p^1 - probability that significant year-to-year variation in occurrence index occurred.
p^2 - probability that occurrence index trend between 1995-2003 differed significantly from zero.
Bold indicates statistical significance at $p < 0.05$.

FIGURES

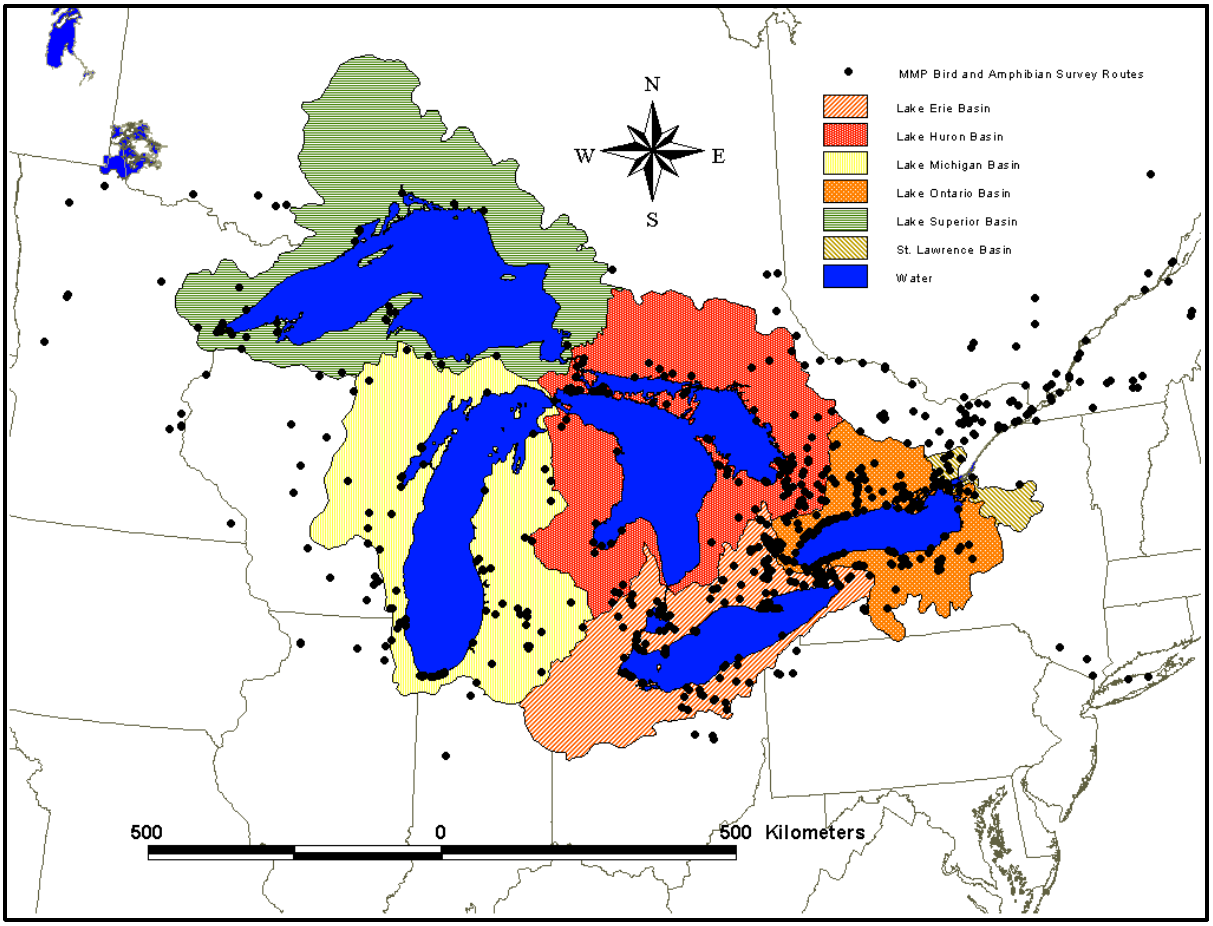
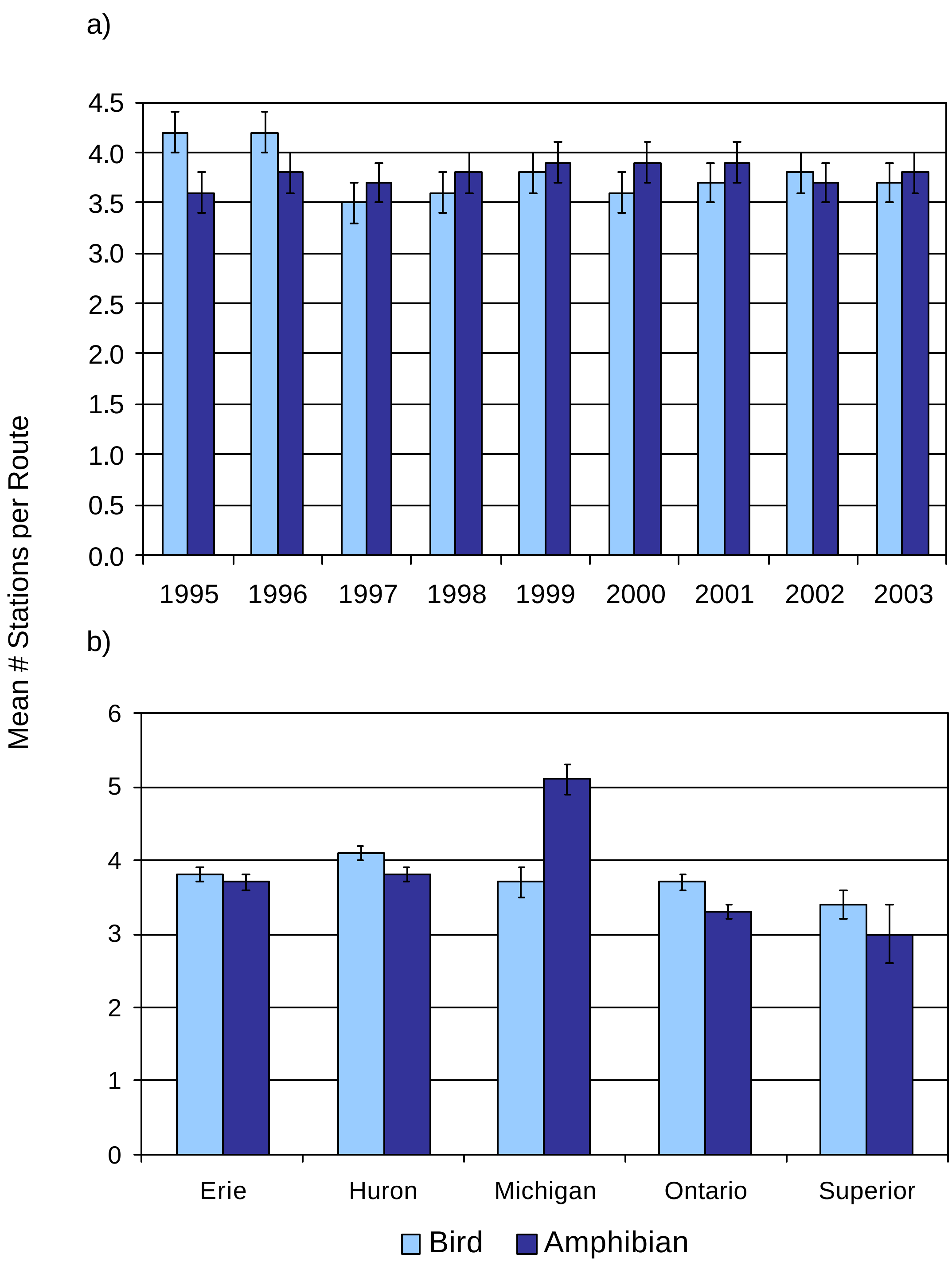


Figure 1. Location of MMP routes (birds and amphibians) throughout the Great Lakes basin 1995-2003

Figure 2. Mean number of survey stations on MMP routes surveyed for amphibians and birds, summarized by a) year and b) lake basin,1995-2002. Black vertical bars show standard errors.



APPENDICES

Appendix 1

Species Code	*Species Name*	*Latin*
ABDU	American Black Duck	*Anas rubripes*
ALFL	Alder Flycatcher	*Empidonax alnorum*
AMBI	American Bittern	*Botaurus lentiginosus*
AMCO	American Coot	*Fulica americana*
BANS	Bank Swallow	*Riparia riparia*
BARS	Barn Swallow	*Hirudo rustica*
BCNH	Black-crowned Night-heron	*Nycticorax nycticorax*
BEKI	Belted Kingfisher	*Megaceryle alcyon*
BLTE	Black Tern	*Chilidonias niger*
BWTE	Blue-winged Teal	*Anas discors*
CAGO	Canada Goose	*Branta canadensis*
CHSW	Chimney Swift	*Chaetura pelagica*
CLSW	Cliff Swallow	*Petrochelidon pyrrhonota*
COGR	Common Grackle	*Quiscalus quiscula*
COMO	Common Moorhen	*Gallinula chloropus*
CONI	Common Nighthawk	*Chordeiles minor*
COSN	Common Snipe	*Capella gallinago*
COYE	Common Yellowthroat	*Geothlypis trichas*
EAKI	Eastern Kingbird	*Tyrannus tyrannus*
FOTE	Forster’s Tern	*Sterna forsteri*
GADW	Gadwall	*Anas strepera*
GBHE	Great Blue Heron	*Ardea Herodias*
GRHE	Green Heron	*Butorides virescens*
GWTE	Green-winged Teal	*Anas crecca*
LEBI	Least Bittern	*Ixobrychus exilis*
MALL	Mallard	*Anas platyrhynchos*
MAWR	Marsh Wren	*Cistothorus palustris*
MOOT	Undifferentiated Moorhen/Coot	
MUSW	Mute Swan	*Cygnus olor*
NOHA	Northern Harrier	*Circus cyaneus*
NRWS	Northern Rough-winged Swallow	*Stelgidopteryx ruficollis*
PBGR	Pied-billed Grebe	*Podilymbus podiceps*
PUMA	Purple Martin	*Pronge subis*
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*
SACR	Sandhill Crane	*Grus canadensis*
SEWR	Sedge Wren	*Cistothorus palustris*
SORA	Sora	*Porzana carolina*
SOSP	Song Sparrow	*Melospiza melodia*
SWSP	Swamp Sparrow	*Melospiza geogiana*

Appendix 1 (Cont'd)

Species Code	*Species Name*	*Latin*
TRES	Tree Swallow	*Iridoprocne bicolor*
VIRA	Virginia Rail	*Rallus limicola*
WILF	Willow Flycatcher	*Empidonax traillii*
YWAR	Yellow Warbler	*Dendroica petechia*

Appendix 2

Species Code	*Species Name*	*Latin*
AMTO	American toad	*Bufo americanus*
BULL	Bullfrog	*Rana catesbeiana*
CGTR	Cope's (Diploid) Grey Treefrog	*Hyla chrysoscelis*
CHFR	Chorus frog	*Acris crepitans*
FOTO	Fowler’s Toad	*Bufo woohhousei fowleri*
GRFR	Green frog	*Rana clamitans*
GRTR	Grey (Tetraploid) Treefrog	*Hyla versicolor*
MIFR	Mink Frog	*Rana septentrionalis*
NLFR	Northern leopard frog	*Rana pipiens*
PIFR	Pickerel frog	*Rana palustris*
SPPE	Spring peeper	*Hyla crucifer*
WOFR	Wood frog	*Rana sylvatica*